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INSTRUMENTS

INDUSTRIAL — SCIENTIFIC

Devoted to the Instrument Problems of all Industries

Vol 1. No. 3 Pittsburgh, Pa. March, 1928

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(1860-1898)

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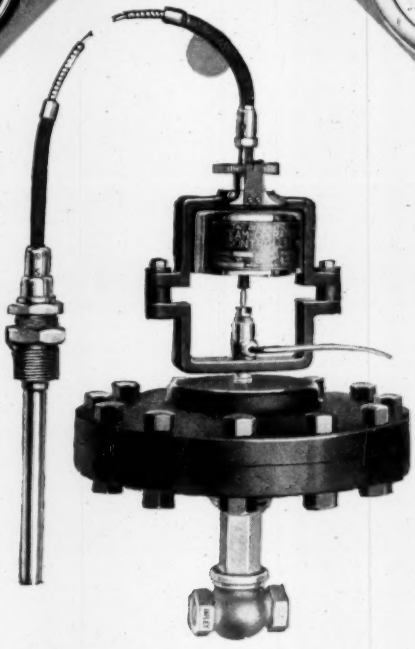
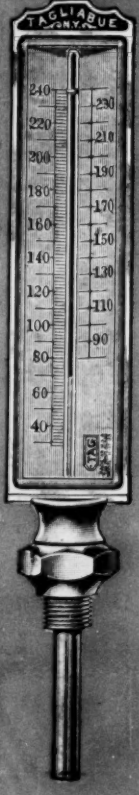
Place initials of interested persons in your organization opposite title and call it to their attention.





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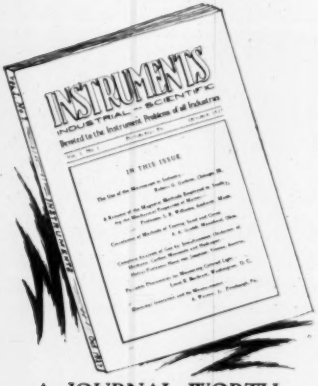

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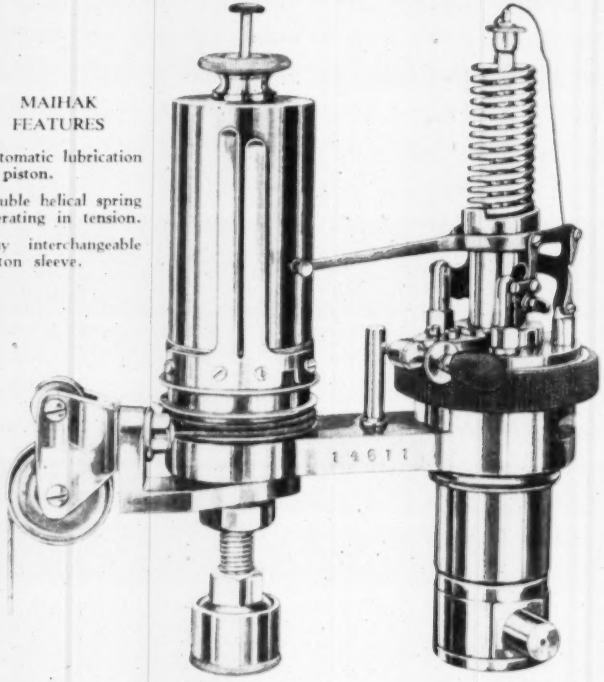

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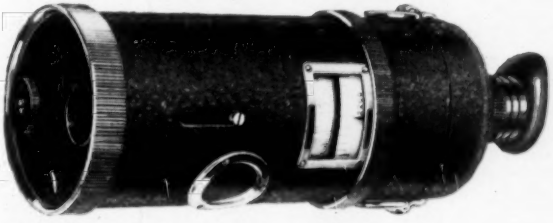

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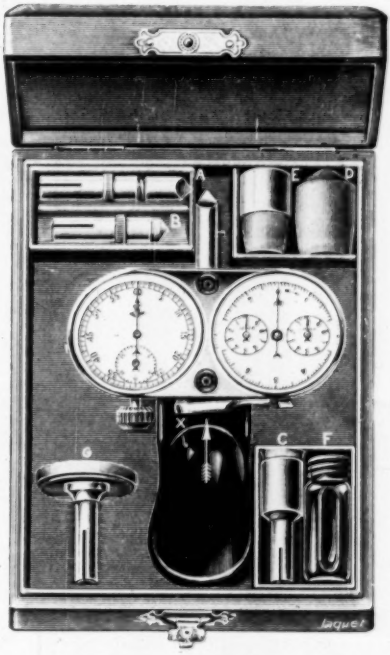

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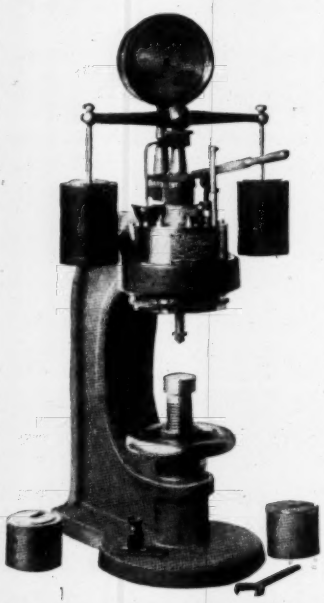

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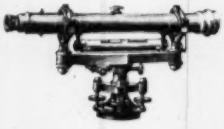

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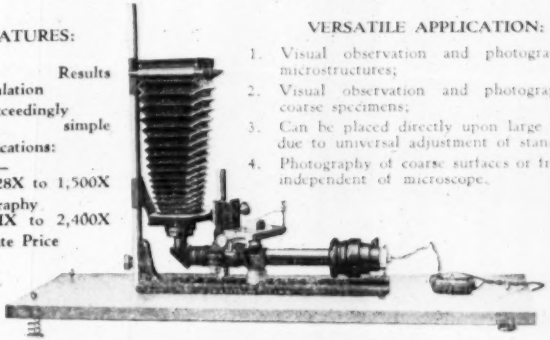

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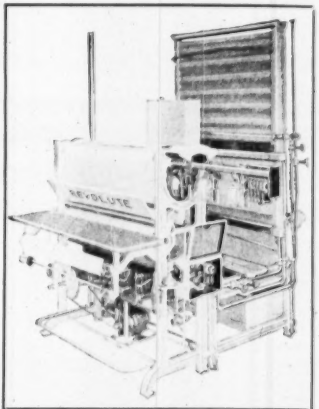

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Published the 15th of each month by

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Vol. 1. No. 3 PITTSBURGH, PA. March 1928

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INSTRUMENTS

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Vol. 1. No. 3. MARCH 1928 Pittsburgh, Pa.

To Our Readers

INSTRUMENTS has undertaken to make available instrument information for all industries in one periodical. Our purpose is to disseminate information on the uses of instruments in the industries, to act as a clearing house for vital information and as a medium for the exchange of ideas on this subject.

The various sections of the magazine made use of to accomplish the above purpose were briefly discussed in the February issue. The editor will this month take up in more detail the file card section which will be found in the back of all issues of INSTRUMENTS.

These file cards are standard international library size of special color, as this will facilitate distinguishing the INSTRUMENTS' file cards from others with which they might be consolidated. No doubt we have all some time or other started an index of articles of interest to us appearing in the trade journals. As this work takes considerable time it probably was discontinued when other work became more pressing.

The editor felt that the work could be performed by the author of the article or an abstractor and printed on cards, at a considerable saving in time to the individual. If an individual receives only one magazine and this contains one or two articles of interest to him, two courses are open:

1. The reader can index and abstract these articles or have someone else do it, which takes between one to two hours to do properly. If the paper appears monthly this will amount to about 20 hours work in a year. Allowing only 50 cents per hour this represents an expenditure of $10.00.

2. If on the other hand the reader does not index the articles but only looks through the magazine, the following occurs: At some future date, the reader remembers that he saw an article at some time on a certain subject and he must then look through his copies of the paper until he finds the information he desires, which entails a considerable loss of time.

INSTRUMENTS' file cards overcome the difficulty. In a few minutes with the aid of shears, file cards, which have all the necessary information on the articles in that issue, may be cut out and filed away. All the information is then available at any and all times.

We are sure that you will want to receive this valuable service each month for the small price of $2.00 per year.

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Our New Collaborator

WE take great pleasure in announcing the addition of another name to the list of our Collaborators:

Dr. John L. Haughton, Senior Assistant, National Physical Laboratory, Teddington, Middlesex, England.

The editor urges all readers to consider themselves as collaborators in the publication of INSTRUMENTS and invites all readers to send in suggestions, criticisms, and interesting information. Another manner in which the reader can assist is to spread the information of this journal among his friends and acquaintances. This is the reason that we have placed subscription blanks in all copies of INSTRUMENTS sent out.

———— :: ————

Do Not Assume That You Know How to Operate this Instrument—Read the Instructions.

INSTRUMENT manufacturers furnish complete sets of concise and easily understandable instructions covering the installation, operation and care of their instruments. It behooves the man assigned to the job of installing and caring for the instruments to read the instructions and not to assume that he fully understands their operation.

Instructions should also be available for reference at all times and not filed away or discarded as soon as the installation is completed. It would be advisable to frame instructions and mount them convenient to the instrument.

———— :: ————

No Back Issues Available

ALTHOUGH over 11,000 copies of both the January and February issues were printed it is at present impossible for us to furnish copies of either of these issues. The circulation manager would appreciate any of our readers returning their copies of these issues if they do not intend saving them for future reference. These returned copies will be sent to those who have requested these issues.

Instruments Appears on the 15th of Each Month

THE editor wishes to advise the readers that INSTRUMENTS' publication date is the 15th of each month. Some of our readers have gained the impression that the publication date is the first of the month and that it comes out later in the month due to delays. Others write in advising us that they have sent us their subscription but that they have not received their copy of the magazine.

There are several reasons for INSTRUMENTS appearing the middle of each month; the most important one is that it does not arrive at a time when more pressing mail is received.

——— :: ———

To the Instrument Manufacturers

IT behooves the instrument manufacturers to lend their support to INSTRUMENTS as soon as possible. This support may take the two following forms:

1. By supplying information.
2. By placing their sales message in INSTRUMENTS.

Considering the first item. Several sections of Instruments depend to a very large extent upon the co-operation of the instrument companies. These sections are listed in the order of their importance:

1. New Instruments.
2. Information Section.
3. Catalogue Library.

In the NEW INSTRUMENT SECTION will be described the new instruments developed by the various companies. This section does not require that the instrument operate on a wholly new principle, never before used. It covers the new instruments made by the manufacturer never made by him before; or radical improvements or changes in the instruments previously made by him. The editor desires that this section be as complete as possible and therefore urges the manufacturers to furnish such information. The articles in this section should be about 1000 words in length, including illustrations.

The INFORMATION SECTION receives questions as to the sources of various types of instruments and these questions can only be answered properly if INSTRUMENTS receives a complete set of all catalogues and bulletins, issued by the manufacturers, for our technical file.

The CATALOGUE LIBRARY attempts to list all new literature issued by the various companies. The editor therefore suggests that the manufacturers send copies of all new literature to him so that it can be listed in this section.

As regards advertising the editor suggests you read page 32 where our business manager has a message for all the instrument companies.

Contents of Subsequent Issues

Historical Sketches of Men who have contributed to the advancement of the Instrument Science.
Why Not Build Aircraft Instruments.
Temperature Control in Process Industries.
Correct Connections for Polyphase Watt Meters.
The Measurement of High Temperature by Radiation Pyrometers.
Modern Precision Measuring Tools for Machine Shop Use.
Why Flyers Need Instruments.
Organization in Research.
Weighing Devices.
Conservation through Metering.
The Measurement of Illumination.
Flow Measurement.
Blind Flying Instruments.
Automatic Combustion Control.
Optical Pyrometry.
Thermometry.
The Importance of Measurements in the Power Plant.
The Care of Measuring Instruments.
Equipment Used in Aerial Surveying.
Automatic Control of High Temperatures.
The Measurement of Boiler Combustion Zone Temperatures.
Fluid Meters.
How Lindbergh Got Across.
Instruments for Geodetic Prospecting.
Dilatometry.
The Measurement of Pressure.
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Engine Indicators.
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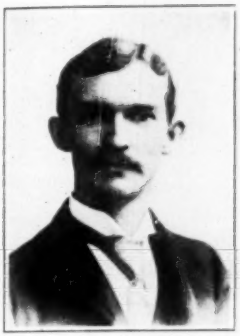
Instruments to improve Diesel Engine Efficiency.
Comparison of Instruments for Measuring Hardness.



Instrument Pioneers

Oliver Blackburn Shallenberger (1860-1898)

OLIVER BLACKBURN SHALLENBERGER was born at Rochester, Pennsylvania, May 7th, 1860. His father, Dr. A. T. Shallenberger, was one of the leading physicians of western Pennsylvania. Upon his mother's side he descended from the Bonbright family of Youngstown, Pennsylvania.

He received his early education at the public schools of Rochester, and at Beaver College. In 1877 he entered the Naval Academy at Annapolis, as cadet engineer. Out of the one hundred and twenty-six candidates examined, twenty-five were admitted and Shallenberger entered at the head of his class. He held this position throughout the year. The work of his second and third years was seriously interfered with, first by an accident resulting in a broken arm and a dislocated wrist, and afterward by impaired eye-sight which compelled him to abandon night study. Notwithstanding these disabilities, he held third position in his class at the end of his course.

The department of physics at Annapolis occupied a prominent position in the curriculum at the time of Shallenberger's entrance, and particular attention was given to electricity. Shallenberger found in this line of work a field peculiarly congenial to his tastes, and was enabled to indulge his natural inclinations toward original experimental investigations. The systematic training and thorough knowledge of the fundamental principles of physics which he was thus able to acquire, formed the basis of his subsequent careful work, and enabled him to readily and accurately shape the directions of his investigations along lines in which he was always surprisingly free from erroneous conclusions and those deviations and vagaries which are characteristic of many inventive minds. After completing the three years' course at Annapolis, he took the customary two years' cruise upon a government vessel. He was assigned to the U. S. flagship *Lancaster*, and the greater portion of the time was spent in the Mediterranean. The most notable experience of these two years was that of witnessing the bombardment of Alexandria. The vivid pictures of different scenes of this event

which Shallenberger's clear, concise style and remarkable command of language enabled him to give, were always full of fascinating interest to his friends. Among his contemporaries at the Naval Academy were Frank J. Sprague, Dr. Louis Duncan, W. F. C. Hasson, Gilbert Wilkes, and several others whose names are prominent among electrical engineers.

In 1883 he returned to the United States, and in 1884 resigned from the naval service and thereafter devoted his entire attention to the science of electricity. The Union Switch and Signal Company, under the management of George Westinghouse, was at that time organizing an electric light department, and Shallenberger became associated with that work. His genius and executive ability were at once recognized, and he was selected to take charge of the experiments made the following summer and fall with the Gaulard and Gibbs alternating current apparatus which Westinghouse imported from Europe. During this period Shallenberger was associated with William Stanley and Reginald Belfield in the commercial development of the alternating current system. The results of the investigations made by the Union Switch and Signal Company led Westinghouse to organize the Westinghouse Electric Company, and Shallenberger was appointed Chief Electrician of that company and later of its successor, the Westinghouse Electric and Manufacturing Company.

In 1889 he went abroad and spent a considerable time in visiting the central stations in many of the larger European cities. In 1891 failing health compelled him to resign his position as Chief Electrician, but the Westinghouse company, unwilling to part with his services, retained him as Consulting Electrician. The succeeding winters he was compelled to spend in Colorado, but the summer months were spent at his home in Rochester, where he continued his work at a well equipped laboratory near his residence.

In 1897 he organized the Colorado Electric Power Company, of which he was President at the time of his death. He returned to Colorado in October of 1897, accompanied by his wife, Mary Woolslair Shallenberger, whom he married November 27, 1889, and their two children, a son and a daughter. His strength gradually waned, and during the evening of January 23rd, 1898, he passed away.

Twenty-four years devoted to education, and fourteen years spent in giving to the world the fruits of his splendid intellect, span the brief period of his life, but each year of that short life witnessed the cultivation of a most lovable character, the development of a masterly mind, and lasting benefits to his fellowmen.

It would be interesting, indeed, to review many of Shallenberger's important contributions to the electrical art and to trace back to his engineering skill many of the essential features which are utilized in the modern systems of electrical distribution. He invented the street

lighting system in which each of a series of incandescent lamps is shunted by a reactive coil having its winding so proportioned to the mass of iron in its core that upon the interruption of the current through any lamp, a normal current is allowed to flow through the corresponding coil to the remaining lamps by reason of the consequent high magnetic saturation of its core. The construction of converters with primary and secondary coils separately wound and insulated was originated by him. He also was the first, in this country at least, to connect alternating current generators in parallel circuit, and he devised ingenious methods and apparatus for that purpose. The compensating indicators for showing at the central station the condition of the consumption circuit were worked out by him. His last work was in producing a series of alternating current recording and indicating wattmeters for accurately measuring the energy consumed upon inductive as well as non-inductive circuits, and compensating for variations in temperature and rates of alternation. But of all his inventions, the development of the current meter bearing his name is surrounded with the greatest interest, not alone because of its intrinsic value and importance, but because it illustrates the character and mental aptitude of the man. While testing an experimental arc lamp upon an alternating current circuit, his attention was attracted by the rotation of a small spiral spring, which dislodged from its position in the lamp, had fallen upon the brass head of the magnet-spool adjacent to a projecting core of iron wires. The motion was so slow as to be scarcely perceptible, but it did not escape his quick observation. He realized at once that he was in the presence of a new phenomenon. All his energies were immediately devoted to ascertaining the cause. Experiment followed experiment in rapid succession. Before he left the laboratory that night he developed from this accidental suggestion the complete conception of the alternating current meter, an object for which he, as well as many others, had for many months sought in vain. He pursued his further experiments with such zeal and good judgment that within a month he had produced a complete working meter, in essentially the same form that it is manufactured today.

It is a curious but well recognized fact that important inventions and brilliant discoveries are often independently made by different people in widely separated localities, and the history of the production of the rotary field motor, an essential part of the Shallenberger meter, contains a striking instance of this phenomenon. While Shallenberger was producing his meter in Pittsburgh, Tesla in New York was preparing to make public the wonderful discoveries which he had made in alternating current motors. Professor Ferraris, at Turin, contemplating with the delight of a profound scientist the beauty of a mathematical theory successfully demonstrated by the workings of physical apparatus, had prepared a paper descriptive of the theory of operation of a small

motor which he had previously constructed, and suggesting it applicability to electric meters. Shallenberger's discovery was made during the week ending April 20th, 1888. Tesla presented the paper regarding his memorable work before the American Institute of Electrical Engineers on the evening of May 1, 1888, the same day that his patents were issued. Professor Ferraris' article appeared in a journal which, while bearing a somewhat earlier nominal date, was actually published during either the last week of April or the early part of May. The results of the work of each of these three brilliant inventors was characteristic of their respective mental attributes, and while neither might have arrived at the special utilization of the others, they independently discovered the fundamental theory of the rotating field, one through an inventor's intuitive process of reasoning, another through pure mathematical calculations, and the third through a quick perception and intelligent appreciation of the presence of an unusual phenomenon.

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Instrument Pioneers

WHEN a man awakes in this world, he discovers that fate has established a channel through which his life must flow. Man's heredity, his time and place of existence, and the natural laws to which he must be obedient are determined without the individual having been consulted. Among the forces out of the Past, which control man's life, are the influences of the men who lived in the Past. To some folk it appears as though man was a ghost in which walk the dead ideas and lifeless beliefs of past generations. "Hands cold and dead seem to mould him from the grave."

Man also has a free spirit within him. This spirit is not a part of these external influences. Man would have his entire being as free as is this inner force of his being. Because man misinterprets this liberty he seeks, he often endeavors to destroy entirely the influence which the Past exerts over his life. Such men are like wanderers in the night who extinguish their torches in an effort to discern a distant light. But there is no distant light and the wanderers are lost in the darkness.

Rightly understood, however, these hands which reach to us out of the Past are friendly hands which transmit to us a helpful light. This beneficent influence of the Past surrounds us on all sides. We walk in parks that past hands laid out; we work with machines that past hands constructed; we enjoy beautiful buildings that past hands erected; we benefit by the knowledge that past hands laboriously accumulated.

This new section started in INSTRUMENTS last month will cover the lives of the various scientists and engineers, who by their contributions to the science of instruments influenced the later developments in the fields in which they worked.

Humidity Test Equipment

By E. B. Wood*

MILDEWED garments and swelling or sticking bureau drawers are commonplace phenomena in the summer time. They are particularly so in rainy weather. In winter, on the other hand, in heated homes, a shrinkage or warping of furniture and doors is equally common. If we seek the causes of these changes in materials between summer and winter we find it due to the amount of moisture or water vapor which is in the air and therefore available for absorption by wood or other fibrous or absorbing substances. In a room having a volume of one thousand cubic feet the air in winter contains normally less than one-fifth of a pint of water in the form of vapor while in summer the amount may be one and a half pints, or more than seven times the winter quantity.

The amount of water vapor in the air is generally measured in per cent of the maximum amount the air can hold at that temperature and pressure. This percentage is usually spoken of as the relative humidity. The summer condition mentioned above corresponding to approximately ninety per cent relative humidity at 85 degrees Fahrenheit is so near to the saturation point that the addition of one-fifth of a pint of vaporized water or a drop of three degrees in temperature would result in the formation of fog.

It is not surprising in view of these data and experiences that telephone apparatus with its complex electrical circuits and closely adjusted moving parts should be especially susceptible to the effects of moisture. The importance of such effects has been recognized in the design of telephone apparatus for many years. However, as the extension of machine-switching and long distance communication systems has demanded closer operating limits and more rigid requirements for apparatus, the importance of atmospheric conditions has greatly increased and a more precise knowledge of their effects has been required.

In response to the demand for improved facilities for the study of the effects of humidity, laboratory testing methods and equipment have been completely revised within recent years and additional testing facilities are constantly being provided as the volume of humidity testing increases. The equipment in present use in the General Development Laboratory of the Bell Telephone Laboratories may be divided into three groups comprising large cork insulated rooms, air-tight stationary chambers and small portable units.

In the first group we have three rooms, each of approximately 1500 cubic feet capacity. The temperature and humidity of each are con-

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trolled by a system of sprays and water-cooled radiators or electric heaters, through which the air from the room is circulated by a centrifugal blower and so is conditioned as desired. This apparatus is capable of reproducing atmospheric conditions ranging from 30% to 95% in humidity and from 70 degrees to 110 degrees F. in temperature, thus covering practically the entire range of conditions normally existing in telephone buildings. The operation of the equipment is automatic and the accuracy normally obtained is plus or minus one per cent in humidity and plus or minus one-half degree F. in temperature. These rooms are large enough to permit the testing under actual operating conditions of

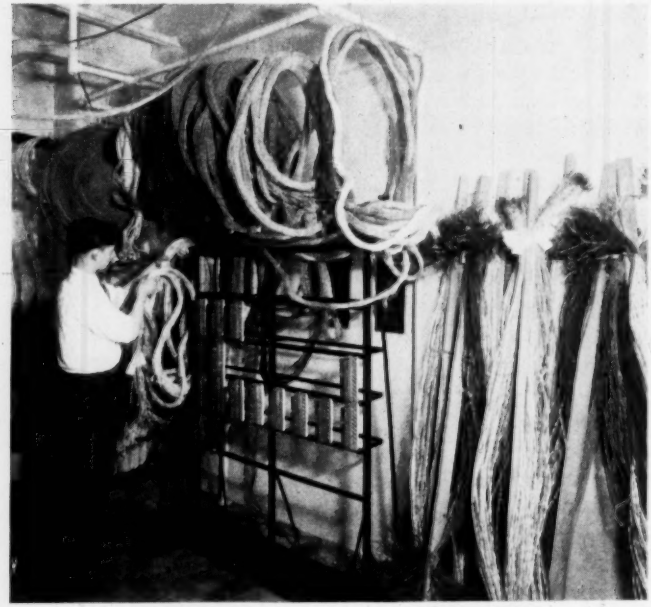


Fig. 1. Interior of large cork-insulated room, showing cable wires and terminal blocks undergoing test.

large pieces of assembled apparatus as well as small parts and raw materials. An important feature of this equipment is its flexibility, permitting sudden changes in humidity and temperature to be made and thereby allowing apparatus to be studied under the fluctuating conditions which have been found to exist in nature.

In the second group we have two chambers, one of fifty and the other of four cubic feet capacity. These consist of an inner air-tight chamber within a surrounding compartment which is thoroughly heat-insulated from the outside air. The humidity in the inner chamber is controlled

by the use of a solution of sulphuric acid contained in a large shallow lead tray over which the air is circulated by a fan. The manner in which the sulphuric acid and water control the humidity will be discussed later. The temperature is controlled by thermostatically regulated electric heaters located in the eight-inch surrounding compartment. For temperatures below room temperature an ice-box is provided through which the air in the outer enclosure is circulated by a blower. The walls of the inner chamber are composed of layers of wood, paper, air spaces and cork, and heating and cooling are accomplished by means of heat con-

Fig. 2. Small air-tight chamber for accurate humidity control

duction through these walls from the outer air spaces. This arrangement lends itself to extremely accurate control of temperature and humidity within the inner enclosure, the variations under normal operating conditions being too small for measurement. This may be called precision equipment. It is best adapted for use in tests requiring constant humidity and temperature for comparatively long periods such as corrosion tests, or for tests requiring extremely accurate and constant atmospheric conditions.

The type of portable equipment comprising the third group was developed in response to the demand for a low cost equipment suitable for

use in commercial inspection-testing of raw materials and manufactured articles such as wire and small apparatus, and to provide additional equipment for laboratory testing. Twelve or more of these units are now available, each having a capacity of approximately eight cubic feet. This equipment consists of a large earthenware crock surrounded by a wooden case, the space between the crock and case being filled with granular cork for heat insulation. A thick wood top is provided on which is mounted a small blower for circulating the air in the crock, a rack for holding samples, and a heater lamp controlled by a thermostat located in the blower intake duct. Humidity is controlled by a saturated solution of a suitable inorganic salt. The humidity within the enclosure is measured by means of wet and dry bulb thermometers inserted in the blower intake duct through a cork.

The equipment is capable of producing humidity conditions ranging from thirty per cent to ninety per cent and temperatures from approximately room temperatures to 100 degrees F. No provision is made for obtaining conditions below room temperature, but if such a condition is required, the whole apparatus may be placed in a cooled enclosure. Under normal operating conditions, the humidity is maintained within plus or minus two per cent and the temperature within plus or minus one degree F.

The use made of the sulphuric acid and saturated salt solutions rests on some very interesting physical facts. If pure water is placed in an air-tight chamber, the humidity will increase until saturation or 100% relative humidity is reached. According to the accepted theory molecules of water moving about in the liquid at high velocity escape above it. Some molecules return but the number returning is less than the number escaping and consequently the amount of water vapor in the space increases steadily until finally the number returning is equal to the number escaping and no further increase in water vapor is possible. The space is then said to be saturated and the relative humidity is one hundred per cent. The vapor exerts a pressure inside the chamber and that exerted at one hundred per cent humidity is called the vapor pressure of the water at that particular temperature and pressure. The relative humidity at any time during this evaporation process may be defined as the ratio of the number of molecules per unit volume to the number per unit volume at saturation, or since for a given temperature the vapor pressure is proportional to the number of molecules the relative humidity may be defined as the ratio of the vapor pressure in the space above to the vapor pressure of the liquid.

If a soluble material which has practically no vapor pressure of its own is added to the water, the vapor pressure of the solution becomes less than that of pure water. Therefore, if an aqueous solution such as a sulphuric acid or soluble salt solution is placed in the chamber, the humidity at equilibrium will be less than one hundred per cent; choice

of the proper concentration will give whatever predetermined humidity condition may be desired.

For humidity control systems which are practically air-tight, sulphuric acid solutions possess certain advantages over saturated salt solutions. Humidities ranging from five per cent to one hundred per cent may readily be obtained by simply varying the concentration of the solution. The effect of small changes in temperature on the resulting humidity is negligible, the change in humidity being in general less than one-tenth per cent per degree centigrade. Sulphuric acid itself has practically no

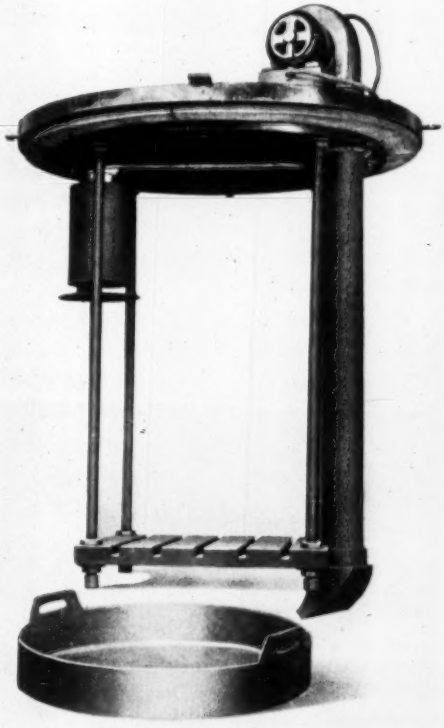


Fig. 3. Portable heating and circulating equipment, used with a crock which forms the testing chamber.

vapor pressure, the most delicate tests having failed to indicate any trace of acid fumes in the atmosphere of the test chamber.

For humidity equipments which are not completely air-tight, such as the portable units described above, sulphuric acid solutions or other unsaturated solutions are not satisfactory since the concentration gradually changes by evaporation or by the addition of water absorbed from the atmosphere. This difficulty has been overcome satisfactorily, however, by the use of saturated salt solutions. As an example, a saturated solution of sodium chloride (common salt) has a definite vapor pressure at a

given temperature which will give a humidity of seventy-five per cent. If an excess of the salt is present in the solution the addition or evaporation of water has no effect upon the vapor pressure since the solution is at all times saturated. Thus it is possible to maintain a practically constant humidity in a non-air-tight system provided, of course, that reasonable precautions to restrict air leakage are observed.

Data are available in the literature on the vapor pressures of saturated solutions of soluble materials which may be used to control humidity over a wide range. Also in many cases, two or more salts may be used in combination to increase the range of humidity obtainable by this method. In the laboratories, this method has been used mainly for maintaining humidities ranging from sixty-five per cent to ninety-five per cent, but it is known that humidities at least as low as thirty per cent are similarly obtainable.

In the use of this method some precautions should be observed. Temperature has in general much greater effect upon the vapor pressure than is the case with sulphuric acid solutions. In some cases the vapor pressure-temperature curve is apparently irregular. The stability characteristic of each salt should also be known in order to insure freedom from gaseous impurities in the test chamber. In short, each salt must be given careful consideration as to its characteristics before being used. Such precautions having been observed, however, saturated salt solutions have the advantage of being inexpensive, easy and safe to handle and requiring no maintenance even though the conditioning period may extend over many months.

Instruments Welcomes the New Instrument Paper.

The editor has just received an announcement of "The Instrument World, a new monthly journal for designers, makers, vendors and users of scientific instruments," which is to appear in England in May of this year. INSTRUMENTS wishes this new publication every success.

There is no doubt that publications on instruments would not have been possible some years ago. Instruments play an important part in modern industry. There is, indeed, hardly a development of note that has not been made possible by the results obtained by the use of instruments. The conservation of natural resources is being accomplished. New sources of power are being located and harnessed.

These papers present an effective medium for publicity to the instrument companies as they cover a specialized field. Experience in all industries has proved the value of specialized journals.

Instruments for the Measurement of Electrical Insulation

By A. Watson, Pittsburgh, Penna.

(Continued from the February issue)

WE will now consider the measurement of true insulation qualities in so far as the life of the material is concerned—leakage over the surface and through the material.

From the practical standpoint it is seldom necessary to separate the two quantities; as the total combined resistance is the important thing. To prepare the sample for test it is placed between two sheets of tinfoil backed with several thicknesses of dry blotting paper and weights are placed on top to insure even distribution of contact. Extension leads of tinfoil are carried out and soldered to copper leads.

The insulation value may be measured by the following methods:

1. Wheatstone Bridge Method.
2. High Resistance Galvanometer Method.
3. Megohmmeter, which reads directly in megohms.

The Wheatstone bridge method is limited to the measurements of resistance under 0.5 megohms, as even with this low value, a greater accuracy than 5% is seldom obtained due to the high ratios of the bridge arms required.

The voltmeter is at present only used by telephone and telegraph companies. Almost every wire-chief's desk being equipped with a voltmeter of approximately 1000 ohms per volt for testing for so-called "escape of line wires." With such a voltmeter and a steady source of D.C. potential very good results can be obtained, when the resistance to be measured is from 0.1 to 5 megohms. With higher resistance, it is difficult to measure with any degree of accuracy.

The voltmeter method remains as the best for making such measurements as resistance of sheet materials and on high voltage cables before installation, as for example, when making acceptance tests at the factory.

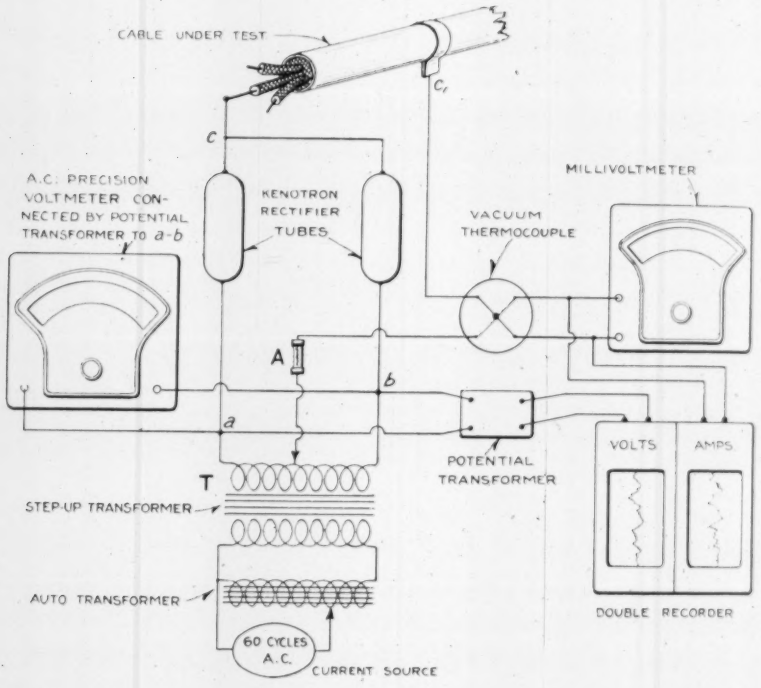
The measurement is made as follows: a reading directly across the battery or generator is taken, then a second reading is taken with the unknown resistance in series with the current source and voltmeter or galvanometer. Then

$$R\,(\text{in ohms}) = \frac{r_v\,(d - d_1)}{d_1}$$

where r_v = resistance of the voltmeter.
d = deflection of the voltmeter across the battery.
d_1 = deflection of the voltmeter in series with the current source and the resistance under test.

What is today recognized as the most reliable method of measuring

such high resistances as insulation (resistances of finished equipment such as motors, generators, wiring and installed cables) is by the use of the megohmmeter. The instruments available on the market today operate on a similar principle—two separate d' Arsonal type galvanometer coils are mounted on a common shaft, electrically they are connected so that the turning moment of the one coil, called the voltage coil, is opposed by the second coil, until a magnetic balance exists, the current in this second coil being the leakage current through the resistance under test. Current is led into these coils by special hair springs so designed as to exert no rotative tension. The movement of the pointer is due entirely to the differential action of the coils which are both located in the same magnet field.



These instruments are substantially built and their reliability and accuracy is remarkable, considering the various tests they can make. They can be furnished in many ranges, to read as low as one ohm and by changing a few connections as high as 1000 megohms, with the same accuracy as can be obtained with a precision high-resistance voltmeter, with the distinct advantage that they read directly in ohms or megohms, no calculations being necessary. They are as reliable in the hands of a novice as in the hands of a trained engineer.

For the measurement of resistances above the range of 1000 megohms, such as small and fairly thick samples (also used by several power companies for the measurement of high tension cables and line wires), the "Kenotron" tube with transformers may be used. Such a circuit is shown in Fig. 7 adapted to cable testing.

With such an apparatus an extremely high D. C. potential may be applied. It will be noticed that the voltage measurement is made with a potential transformer and low voltage voltmeter both indicating and recording. Where the exact ratio of the main transformer "T" is known it is possible to take the voltage across the primary. A simple calculation then gives both the secondary A. C. voltage as well as the D. C. potential applied at c and c_1. The indicating instruments are not necessary where the recorder is used, but are shown in the figure. Where the indicating instruments alone are used it is necessary to have several observers and this makes the exact measurement somewhat more different than where the double recorder is used. At "A" is shown a fine wire fuse for protection if the insulation should break down unexpectedly, this fine wire may be shunted with a high resistance sensitive relay so arranged to operate a circuit breaker in the primary supply circuit to prevent excessive damage should a breakdown occur.

The method of measurement is to observe the shape of the curve obtained on the ampere scale and to take a reading of voltage and current when the curve settles to approximately a straight line, or to take the current and potential reading when a desired potential has been reached and maintained for a definite period.

At the start of such a test with the apparatus connected to say a high tension cable due to the rather high potential and also rather high capacity between the wires under test, a fairly heavy charging current will flow. For this reason the shape of the curve in many cases is a clue to the insulation value as much as the exact current and potentials involved.

With a rather long cable in good condition, the charging current while at high start will rapidly drop to a point near zero current and stay at this value until the potential strain is so great that a puncture may occur. All of this must be considered and while on original test the insulation may have stood a potential many times that under operating conditions, it would be unreasonable to subject the cable to the same test potential after being in operation for any great period of time.

Therefore, a potential should be chosen to give a reasonable factor of safety and repeated tests made at this potential at frequent intervals to show whether the insulation value is being maintained. Many cables which originally may have stood a test potential of ten times the operating might after several months of service break down with say five times the operating potential and yet this same cable have maintained a good life under normal operating conditions.

This is mentioned because the author has many times heard engineers say that such insulation tests are valueless whereas the selection of test potentials was wrong. A value of three times the operating potential is usually all that is required, this will give the true insulation resistance in ohms without the danger of a local breakdown.

Moisture, dirt, dust and high operating temperatures are the bugbears of electrical insulation, and when a clean, dry, cool location cannot be provided, the equipment requires more attention than where these conditions prevail. The life of many machines, operating under severe conditions, can be considerably lengthened at very small cost by periodic cleaning, drying and simultaneous checking of the insulation resistance.

A weekly check of the insulation under severe conditions or monthly if not so rigorous should be made by the methods indicated above. As long as the results are consistent the condition of the insulation would ordinarily be considered good. A gradual, but certain lowering of the resistance will indicate, in ample time that a machine should be cut out of service and given a more thorough inspection.

Disconnecting the windings of the machines in coils or groups will generally show that some one coil or group is different than the other coil or groups. Introducing new insulation in the weak spot may save a complete rewinding of the machine, which costs nearly as much as a new machine.

The A. I. E. E. states that the insulation of a machine should conform to that calculated from the formula:

$$\text{Insulation resistance in megohms} = \frac{\text{Voltage at terminals}}{\text{Rating in KVA} + 1000.}$$

This formula applies only to dry apparatus and generally to new. While many new dry machines have insulation values exceeding that calculated from the above formula, any number of new and rewound machines with much lower values, have given good service. It must be borne in mind that this applies to machines at operating temperatures, and that the same machine when tested at a much lower temperature should have a value of three to ten times as large.

As the insulation resistance may vary slightly with the test voltages, it is best to use the same test voltage at all times, this voltage being from two to five times the operating voltage for apparatus on potentials up to 1000 volts. At higher potentials the resistance should be measured at operating voltage following this with a high potential breakdown test using a potential from two to ten times the operating voltage.

It is the author's contention that the use of the high potential test on low voltage machines may cause a weakening of the insulation, which if tested for resistance only, would show satisfactory, whereas if the high potential test is used, it should be followed up with a resistance measurement using a potential of twice the operating voltage to determine if the insulation has been weakened at any point.

The direct reading megohmmeter is the best instrument for such test work as it contains its own generating source, the voltage being governed by the speed of the driving crank. The output of the generator is so small that if a breakdown should occur during the test, the damage to the winding is so slight that it can easily be repaired and retested.

The testing of small apparatus, low potential wires and cables can be carried out with the megohmmeter. Small apparatus as relays, voltmeters, ammeters, etc., should on being subjected to a test with 500 or 1000 volts show infinity, as the insulating parts are small and have little volume. When the resistance is less than infinity it is usually due to moisture or to accumulations of conducting dust or in some cases only a single faulty bushing. Brushing the various insulating bushings with a stiff brush usually brings the resistance back to its proper value—in any event when brushing does not bring the desired result, unsuitable material may have been used and reinsulation should be resorted to.

In conclusion, it may be stated that the insulation resistance of machines of a given size need not have a definite fixed value, but that even though a low value be found, this low value should remain over long periods when tested under similar conditions. If it is found that this value is continually falling off it is advisable to overhaul the machine.

A systematic and periodic inspection of wires and cables and plotting curves, will in many cases with the proper supervision prevent expensive "burn-outs" and in addition prevent the loss of current through leakage.

A wise maintenance engineer will not permit poor insulation conditions to exist, but these conditions can only be avoided by consistant systematic inspections and records.

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Determination of Specific Gravity, Surface Moisture and Voids in the Fine Aggregate for Use in Concrete Mixtures

*By Cloyd M. Chapman, New York, N. Y.***

THE water-cement ratio theory developed and published by Abrams at Lewis Institute in 1918, is becoming more and more generally accepted as the most practical method so far offered to the concrete industry for both the design and field control of concrete mixtures to give a known or predetermined strength. In the application of this method it is necessary that the amount of water entering into each batch of concrete be accurately known and measured. It is even more essential that the exact water content be known than it is that the exact quantity of aggregates be known. Cement, being usually added to the mix in weighed quantities, presents no serious measuring problem. Coarse aggregates may be either measured or weighed with reasonable accuracy and, unless they contain an abnormal amount of water, no correction for water content is usually made. The fine aggregate, however, presents more of a problem. If a definite water-cement ratio is to be accurately or even approximately maintained, it is necessary to take account of the water in the fine aggregate. This may vary from zero to ten per cent. of the weight of the fine aggregate in some cases. In a 1:3:5 mix, with a 5 per cent water content in the fine aggregate, there would be nearly two gallons of water added for each bag of cement in the mix. This may represent something like twenty-five per cent. of the total water called for in the water-cement ratio specification. If ignored it might mean a difference in resulting strength of even more than twenty-five per cent. It is obvious therefore that the water content of the fine aggregate must be known and taken into account if a serious attempt is made to maintain a definite water-cement ratio. One of the difficulties of introducing more universally the use of the theory has been the reluctance of concrete field forces to make tests on the job. Concrete, and most of it good concrete, has been made for so many years by rule-of-thumb methods, using arbitrary proportions for the mix and any amount of water that the foreman thought best, that it is hard to get these men to realize the need for improvement. To suggest the necessity of making moisture determinations of the sand before fixing the amount of water to be added to each batch often brings the retort, "We're not running a laboratory on this job."

**Consulting Engineer.

And there is some excuse for that attitude. To take a sample of sand, weigh it, dry it, weigh it again, compute the loss, and then compute the total water in a batch, and allow for absorbtion, is not a quick and simple operation. It takes time and attention. Drying means either drying equipment of some sort or waiting a longer time for air drying to take place. At any rate, for this or other reasons, moisture determinations have often been either entirely omitted or seldom made.

When the inundation method is used for measuring fine aggregates, it is equally necessary to make accurate determinations of the amount of water which enters the batch with the inundated sand. Sand measured in water does not "bulk" like sand measured in a damp state; but the amount of water in such sand varies with the voids in the inundated sand and this is a variable quantity. A variation of even a few per cent in the voids in an inundated sand would cause such a large variation in the amount of water in the sand, that to ignore it would be as illogical as to ignore the moisture in damp sand. And to determine the voids in an inundated sand is not any simpler or easier in the field than determining moisture.

It was for the purpose of providing a simple, quick, easy method for making determinations of moisture and voids in the field that a new device was introduced recently to the concrete industry.

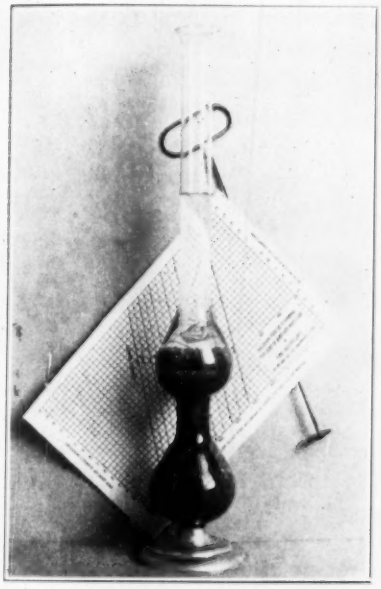
This device is a special double bulb glass flask having a graduated neck and a calibrated volume mark on the constriction between the upper and lower bulbs.

The flask is useful for making determinations of three important physical qualities of fine aggregate, namely, Specific Gravity, Surface Moisture, and Voids When Inundated.

The Specific Gravity determined may be more accurately described as the Approximate Apparent Specific Gravity since the method prescribed for making this determination does not give a result which can truly be called the Specific Gravity of the material tested. For example, if the fine aggregate being tested is porous, no account is taken of these pores. Such of them as are on or close to the surface of the particles may become filled with water during the test and so the displacement of the particle would be reduced by an amount equal to the volume of the water entering the pores. But pores or voids within the particles which do not become filled with water during the test or which were already filled with water before starting the test, are not taken into account in this test.

This inaccuracy of the method of determining Specific Gravity is, however, highly desirable in this particular case. The results are to be used primarily for the purpose of controlling the water-cement ratio in concrete. In computing the ratio of water to cement in a mix the water absorbed by the aggregate or existing within the pores of the aggregate

should be omitted from the total. The new method, using the new flask, provides for the tests for Specific Gravity and for moisture being made with the pores of the aggregate filled with water so that no correction need subsequently be made for absorbtion by the aggregate. This also enables results of Moisture and Inundated Voids test to be expressed either as a per cent. of the aggregate or as gallons per hundred pounds to be found directly from a chart without mathematical computation of results and without making any deduction for the absorbtion of the aggregate.



The flask in its present form is shown in the illustration.

The method of operation is simple and quick. The only apparatus required in addition to the flask is a pair of scales or balances having a capacity of about a kilogram and an accuracy of a half a gram.

The procedure followed in making a determination of Specific Gravity is as follows: The flask is first filled with water up to the 200 cc mark on the intermediate neck between the upper and lower bulbs. Five hundred grams of the sample from which only the surface moisture has been evaporated is then poured into the flask. The combined volume of the mixture is read on the upper graduated neck of the flask and by the aid of a chart the Approximate Apparent Specific Gravity is ascertained.

Fine aggregates from the same source seldom vary much from day to day in specific gravity, so that after one or two determinations have been made it is usually not necessary to continue making them so long as the source of supply is unchanged.

The determination of Surface Moisture is even simpler and consider-

ably quicker although it requires that the above described Specific Gravity determination shall have been made to establish the Specific Gravity of the fine aggregate.

To determine Surface Moisture the flask is filled to the 200 cc mark with water, 500 grams of the damp aggregate is poured into the flask, the resulting volume is read on the upper neck and by means of the chart furnished with the flask either the per cent. of moisture or the gallons of water per hundred pounds of aggregate is read off directly. The whole operation is performed in a very few minutes.

Voids in inundated fine aggregate are just as quickly and simply determined. In this case the flask is filled to the 400 cc mark on the upper neck with water and the aggregate being tested, both water and aggregate being brought to the same level. The flask and contents are then weighed and the weight of the flask deducted. For convenience the net weight of the empty flask is permanently etched upon the glass. From the net weight of the contents of the flask and with the aid of the chart either the per cent. of voids or the gallons of water in a cubic foot of the inundated aggregate is read off directly.

———— :: ————

The first optical pyrometer used in the control of metallurgical operations was developed by Crova at Le Creusot, France, to measure the temperature of the open-hearth furnace, in 1881.

Seger, a German porcelain maker, invented a scale of fusibility, for measuring temperatures in 1883.

Le Chatelier published his researches on pyrometry in 1886. He discovered that a thoroughly satisfactory thermoelectric pyrometer could be made by using a junction of pure platinum with a rhodio-platinum alloy containing 10 per cent rhodium, a D'Arsonval moving coil galvanometer being used as an indicator.

The first successful attempt to secure an automatic record of high temperatures was made by Le Chatelier in conjunction with a thermoelectric pyrometer in 1887.

Mesure and Nouel pyrometer was invented. This was manufactured in Paris in 1888.

Prof. J. Wiborgh of the School of Mines at Stockholm invented a pyrometer in 1888.

Carl H. Barus, at one time physicist of the U.S.G.S., published his memoir on the gas thermometer and the thermoelement in 1891. Holburn & Wien published results of their measurements of temperature, using the air thermometer, up to 1300° C.

Le Chatelier introduced his optical pyrometer in 1892. This was a successful development of the method attempted by Ed. Becquerel in 1863 to deduce temperature from the luminosity of the heated body. He also improved the Mesure and Nouel pyrometer by the addition of a photometer.

Electric Meter History

R. C. Lanphier, Springfield, Illinois

Early Type of Meters

PRIOR to 1880 there was no central-station art as we think of it today. There were very few electric consumers and practically no lighting customers, so that the need for measurement of electric quantity or energy had hardly been felt at that time.

Direct-Current Meters First to be Developed

In the period from 1872 to 1879, a few attempts had been made by such men as Gardiner and Fuller to produce so-called electric meters. But these meters were really nothing more than intermittent-time devices recording the total time that a current existed in an electric circuit.

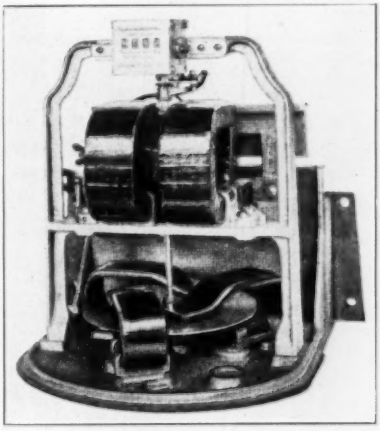


Fig. 1. Original Thomson commutator meter (Type TRW).

A patent for what was probably the first effective meter was taken out in England by John T. Sprague in 1878. This meter was an electrolytic meter in which two copper plates carried on spiral spring supports were made to reverse their polarity alternately when a given weight of metal had been deposited. The quantity of electricity passed was recorded by a train of wheels actuated on each reversal of current.

In 1879 or 1880 the genius of Edison was turned to the development of the central station and parallel distribution to customers became an established and important fact. At this time the need for integrating meters was felt and Edison was the first to solve the problem that presented itself in a commercially satisfactory manner. At that period there was no thought of measuring electrical *energy*, that is, watt-hours. The early Edison meters, and others invented about the same time, were all *quantity* meters measuring coulombs or ampere-hours. Edison invented in the period from 1880 to 1882, two principal types of meters. One was a motor meter which did not appeal to him and which, while patented, was never manufactured

commercially. The other was an electrolytic-deposit meter, well-known as the "Edison chemical meter," described in further detail below.

About the same time Dr. Siemens and Prof. Ayrton in England realized the need of integrating meters. To them is generally ascribed the credit of the first so-called "commutator-motor-type meter." Ayrton is generally credited with conceiving the idea of controlling the speed of a motor meter by utilizing the Foucault principle of a damping disk reacting with permanent magnets. The joint conceptions of Siemens and Ayrton were first reduced to a really successful commercial basis by Prof. Elihu Thomson who brought out the well-known Thomson meter at Lynn in 1888.

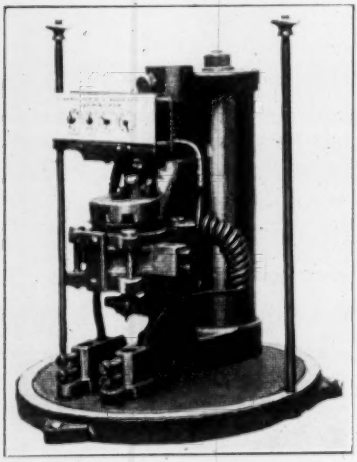


Fig. 2. Early Faraday disk mercury-motor meter, Chamberlain and Hookham, with cover removed.

At the same time, Hookham and Ferranti in England independently developed and announced the first Faraday disk or mercury-motor-type *quantity* meters. In these meters rotation of a copper disk partly or wholly submerged in mercury was produced by the interaction of a suitable permanent magnet with an electric current through the disk.

Early Types of Alternating-Current Meters

In the meantime, about 1886, after the single-phase alternating-current system of distribution became of commercial importance, several engineers in this country and abroad attacked the problem of a type of meter adapted only to alternating current. Prof. Ferraris first enunciated the principle of the rotating field in an address before his students at Turin in 1886 or 1887, his discovery being made in 1885. It is interesting to note that his conception of the rotating field was primarily for the purpose of producing an electric meter, or as then usually termed,

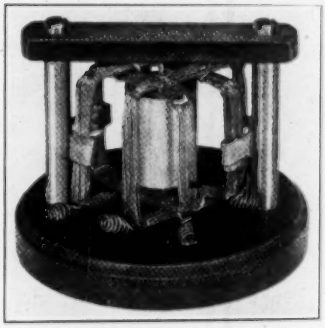


Fig. 3. Ferraris model presented to John W. Lieb in 1922 by the Associazione Elettrotecnica Italiana. It is a true reproduction of the original model made by Ferraris in 1885 and presented to the Accademia della Sienze di Torina, March 18, 1888.

"recording wattmeter." His announcement was immediately followed by the appearance of the first alternating-current meter, made by Borel and Paccaud in France. But the first really great work in the alternating-current meter art was that of Oliver B. Shallenberger, at that time assistant to William Stanley who was then Chief Electrical Engineer of the Westinghouse company. Shallenberger was without question one of the greatest engineers and inventors the electrical art has known. His invention of the first alternating-current amperehour meter, while partly from accidental observation of a peculiar phenomenon one day while working in his laboratory, was of far-reaching importance.

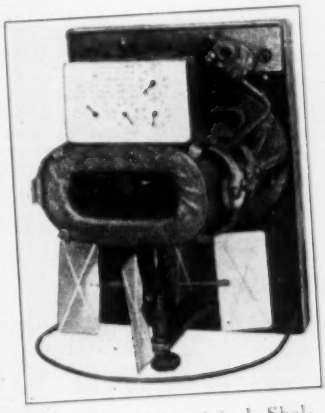


Fig. 4. The original Shallenberger induction amperehour meter with cover removed.

Shallenberger's original meter, produced by the Westinghouse company in 1888, was purely an amperehour meter. It consisted of a pair of coils in series with the line, having within them two short-circuited copper coils set at an angle to the main coils and finally, within these secondary coils, a small disk rotor. Rotation of this disk was produced by the interaction of the out-of-phase fields set up by the main and secondary coils, the speed of rotation thus being proportional to the square of the current. This necessitated a retarding or damping force proportional to the square of the speed. Mr. Shallenberger solved this problem in a most ingenious manner by a system of air-damping vanes carried on the meter shaft. The Shallenberger meter and others such as the Duncan lamp-hour meter developed later, but based on the same principle, continued to be the most important meters in the alternating-current art for nearly ten years, that is until the watthour meter was produced.

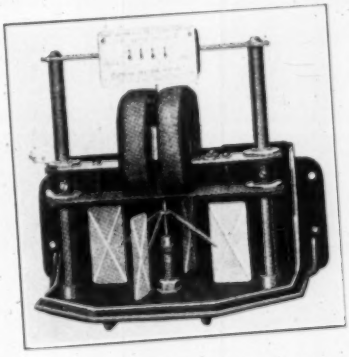


Fig. 5. Duncan lamp-hour meter.

While these meters destined to survive were being developed, many others were conceived, many were patented, and nearly all passed into oblivion. A few, however, embodied real inventive genius and deserve mention—among them, Prof. Thomson's "Oscillating-tube" or "rocking-beam" meter, which he built shortly

fore his famous commutator meter. In this meter a horizontal glass tub with a bulb arranged at each end was centrally mounted on an axis about which it was free to oscillate, its movements being communicated to a train of gears through a suitable ratchet arrangement. The tube and bulbs were partly filled with liquid and each bulb was surrounded by a heating coil so arranged that oscillation of the tube would cut the coils alternately in and out of the circuit. Oscillation of the tube was produced by the coils heating first the one and then the other bulb, thereby causing the liquid to flow alternately out of one bulb and into the other. The rate of oscillation was proportional to the current and since the ratchet arrangement counted the oscillations the total quantity of electricity could be recorded on the dial. This meter was subject to many irregularities and did not survive.

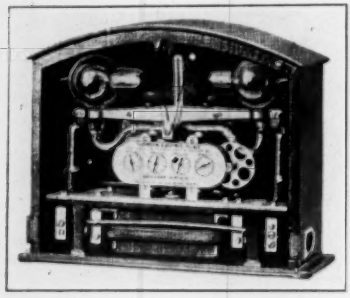


Fig. 6. Thomson Beam Meter, old model with cover removed, as exhibited at Louisiana Purchase Exposition in 1904.

Another interesting meter was the so-called "wind-mill" meter of Prof. George Forbes, the famous Scotch engineer whose advise was so valuable in connection with the early hydro-engineer whose advice was so valuable in connection with the early hydro-electric developments at Niagara Falls. His invention was probably the first important attempt to meter alternating current. The Forbes meter, which was equally suitable for direct current, consisted of a very light spiral vane carried in a tube above a heating coil and attached to a very fine jeweled gear train. The heat from the coil was proportional to the square of the current and the rotation of the spiral vane rotor, retarded under a square law, was proportional to the quantity of energy passed. This meter received the medal of the Franklin Institute in 1888 as a recognition of the inventive genius displayed, but was never commercially manufactured.

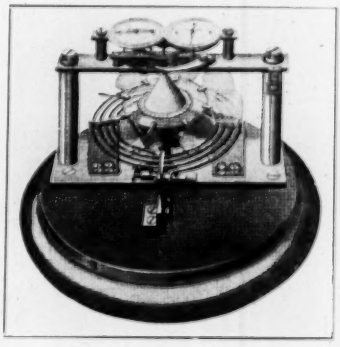


Fig. 7. Professor Forbes' wind-mill meter.

Many other peculiar and freak types of meters were produced in this early period and even so late as 1902, but in recent years all such types have disappeared.

Types of Commutator-Motor Meters

In the early days of the art—in fact until about 1900—commutator motor-type meters, having no iron in the armature or series coils, were widely used on alternating-current circuits, especially where measurement of energy rather than quantity was desired. But since that time this type of meter has had almost its entire application on direct-current circuits. The earliest successful type of motor meter was essentially a small shunt motor, having an armature wound with a number of sections of very fine wire and equipped with a suitable commutator and brushes, connected in series with a high resistance across the circuit to be measured. The main or series coils of commutator-motor type meters are connected in the line so as to carry the entire load current. Motion is transferred from the shaft to a train of gears or register. Speed control is effected by a copper or aluminum disk passing through the gaps of permanent magnets. Light-load compensation or correction for initial friction is obtained in various ways, but all involving the reaction of a coil in the voltage circuit with the armature. This "starting coil," as it is called, has been arranged in some meters of this type to move in and out with respect to the armature; in others to tilt, and in others to swing. In still others the coil has been fixed and its effect varied by a small rheostat cutting in more or less of its turns. This general type of meter has been built in many forms and with many modifications in this country and abroad since 1888. It is still the most widely used type of direct-current watthour meter.

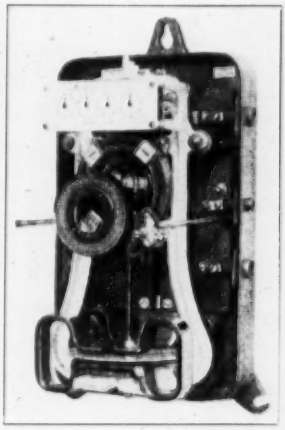


Fig. 8. General Electric modern commutator meter with cover removed.

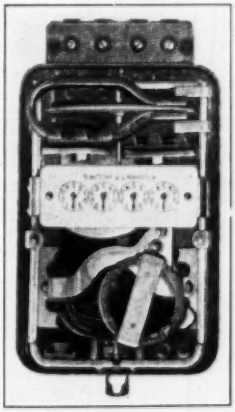


Fig. 9. Duncan modern commutator meter.

Confusion existed for a great many years in the use of the incorrect term, "recording wattmeter," for what is now correctly called "watthour meter." Obviously a recording wattmeter is a graphic instrument recording power values on a chart. Recognizing the inaccuracy of this term, American manufacturers about twenty years ago adopted the better expression "integrating wattmeter." But a few years

later, at the suggestion of the U. S. Bureau of Standards, this term was dropped and all American manufacturers and many foreign ones have since employed the correct term "watthour meter," or "kilowatt-hour meter" for all types of alternating-current and direct-current energy meters. Similarly, the term "amperehour meter" is correctly employed for direct-current quantity meters, there having been no alternating-current quantity meters in use for many years. English manufacturers have long employed the general term, "electricity meter" for both quantity and energy meters.

Another type of direct-current meter that has been widely used in Europe for more than twenty years, although to no extent in this country, is the commutator-type amperehour meter. It consists essentially of an armature connected across a shunt in the line and reacting with the field of a permanent magnet. The driving and retarding forces are thus directly proportional to the current and give an indication on the register of quantity, that is, amperehours. This meter has the advantage from the European standpoint of being considerably cheaper and smaller than a commutator-type watthour meter. It is also considered especially advantageous because, having no voltage coil, it is free from the rather heavy continuous losses found in nearly all commutator-type watthour meters. Many users feel that the lower accuracy of the direct-current commutator amperehour meter on light load as compared with the watthour meter is offset by the elimination of voltage-circuit losses. It is interesting to note in this connection that a modern direct-current watthour meter having a voltage-circuit loss of say four watts at 110 volts, represents a loss in 24 hours of 96 watt-hours, or nearly three kilowatt hours per month. As many small consumers have a consumption of only 15 to 20 kilowatt-hours per month, it can readily be seen that voltage-circuit losses in direct-current meters are a matter of great importance.

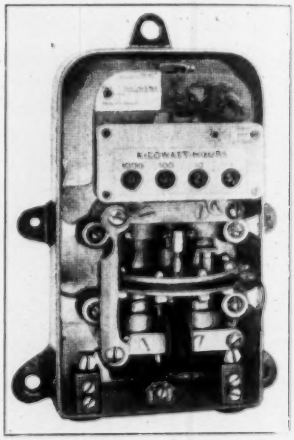


Fig. 10. Modern Ferranti Meter with cover removed

The Development of the Mercury-Motor Meter

The other most important type of direct-current meter is the mercury motor watthour or amperehour meter. From the early meters of Hookham and Ferranti several manufacturers, including the companies founded by these men in England, have developed excellent types of mercury-motor meters, embodying many features not found in other direct-current

meters. Among these features are immunity to stray fields and to heavy vibration and adaptability to use with shunts for heavy loads. All of these features are important from the standpoint of first cost, ease of installation, and calibration. The mercury-motor meter is probably more widely employed today on heavy loads than any other type of direct-current meter.

The mercury-motor-type amperehour meter is almost universally employed in Great Britain on consumers circuits where nearly three-fourths of the consumers are still supplied with direct-current energy. Direct-current watthour meters have never found the favor in Great Britain that they have in this country.

Clock-Work Types of Meters

Another interesting type of direct-current meter and probably the most accurate that has ever been produced, is the Aron differential clock type. This was invented by Dr. Aron in Germany in the late eighties and even to this day it has no equal where the utmost sustained accuracy in measurement of direct-current energy is desired. It is however, far too complicated and expensive for ordinary use and now has small sale. In this meter there is a clock-work having two pendulums, each of which carries a coil energized by the electromotive force of the circuit. These pendulums swing above two coils in series with the line. So long as no electricity passes through the current coils, both pendulums swing at the same rate. Under these conditions the differential gears driving the meter register from the electrically wound clock-work remain stationary. However, the moment the smallest amount of electricity passes through the meter, the periods of oscillation of the pendulums differ in proportion to the energy passing. The differential transmits motion to the register exactly in proportion to the difference in the pendulum rates and energy units are recorded. The curve of the meter remains practically straight up to the highest load, thus giving a most interesting type of instrument.

Fig. 11. Sangamo mercury-type watthour meter as manufactured since 1910, main and terminal-box covers removed.

A number of other so-called "clock-work" meters have been devised, but space does not permit their mention.

Oscillating-Type Meters

Another type, used considerably in the past but to very small extent now, is the oscillating direct-current meter in which an armature moves through an arc under the influence of series fields, instead of rotating. At each end of the armature's travel connections are automatically reversed so that the armature continues to move back and forth from one end of the arc to the other. The oscillations are counted through a suitable ratchet arrangement and recorded as watthours by the gear train. This type of meter has little to commend it.

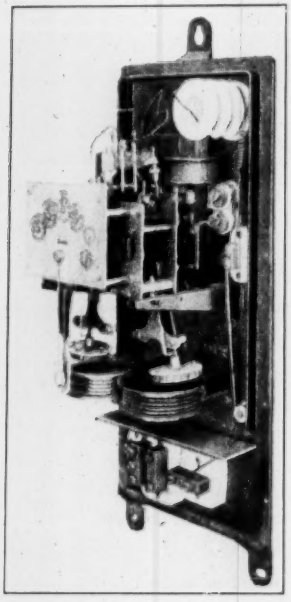


Fig. 12. Aron differential clock-type meter with cover removed.

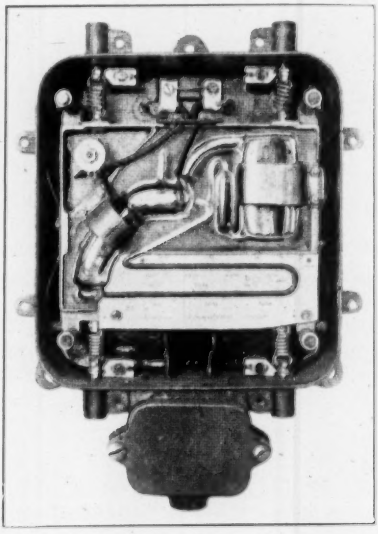


Fig. 13. German gas-type amperehour meter recovered from German submarine, cover removed. Courtesy of U. S. Navy.

Electrolytic Meters

A final and very important general class of direct-current quantity meters, is the electrolytic type, of which there are three general forms. The first are those meters which liberate gas from acid solution. The measure of the quantity of electricity passed is the displacement of liquid by the gas in tubes suitably arranged with respect to a scale reading in ampere-hours.

The second, and probably most interesting type, is the metal-deposit type, of which the original Edison chemical meter is the best example. In this meter there were two zinc plates in a cell filled with electrolyte.

The cell was connected across a suitable shunt in the load circuit. With passage of electricity, zinc was transferred from the anode to the cathode. By weighing the cathode plate at the beginning and end of a period, its increase in weight, and thus the quantity of electricity which had passed was readily ascertained. This type of meter was generally used by the large Edison companies of this country and abroad on their direct-current lighting circuits from the early eighties until about 1900. It was purely a quantity meter, but considering the state of the art in those days, it was admirable in its performance and results. To prevent the electrolyte from freezing in cold weather and thus putting the meter out of commission, a lamp was placed inside the meter.

Fig. 14. Edison chemical meter with cover opened.

The third type of electrolytic meter and the one generally used today, is the mercury-deposit type. The best example of this type is the Reason meter of England and the Stia of Germany, which is based on the Reason patents. In this meter, mercury is precipitated out of chemical solution by the passage of electricity and is carried over into a tube placed before a graduated scale. This scale is so calibrated that the height of the mercury gives a direct reading in ampere-hours. All electrolytic meters, as compared with other types of direct-current meters, have the advantage of recording every unit of electricity that has passed, no matter how small in value compared with the capacity of the meter.

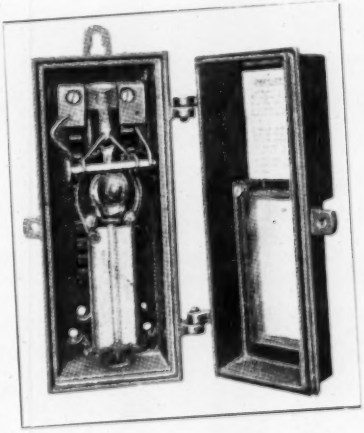


Fig. 15. Reason electrolytic meter with cover opened.

The Development of the Induction-Type Meter

From the beginning of alternating-current distribution until the early 90's, when the polyphase system became a commercial success, there was little need for an alternating-current watthour meter. The Shallenberger amperehour meter already described, or similar meters, were principally used on the single-phase systems. It was obviously possible to use a commutator type watthour meter on alternating-current circuits with reasonably satisfactory results. Meters of this type were used to a considerable extent for measuring energy in single-phase systems until the induction-type watthour meter was developed. Following the Frankfort-Lauffen polyphase transmission in 1894 and the introduction of polyphase motors, the need of a meter adapted to measure correctly inductive loads was recognized. Many inventors of international reputation turned their minds to this problem which was solved by Shallenberger.

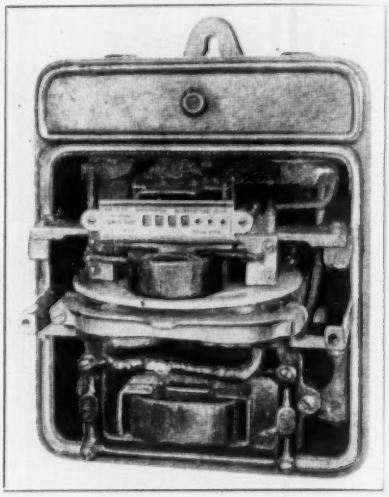


Fig. 16. Shallenberger induction watthour meter of 1896.

An interesting story is told by Charles A. Terry, now Vice-President of the Westinghouse Company, and at that time its patent counsel, about this important invention. Mr. Terry, who was Mr. Shallenberger's intimate friend, was with him at Atlantic City early in 1895. One day while sitting on the sand, Shallenberger spoke of the importance of finding some means of making a small single-phase motor, suitable for use as a meter, and with such relations between its current and voltage elements that the meter would measure correctly at any power-factor of load. He then traced on the sand the vector diagram showing the relations of impressed electromotive force and the phase angle of the voltage circuit of meters made up to that time. He then added the vector of a secondary circuit reacting with the main flux of the voltage-coil circuit so as to give a resultant or effective flux in quadrature relation with the

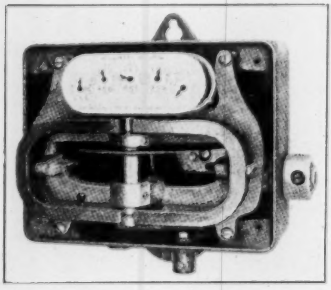


Fig. 17. Stanley watthour meter with cover removed.

impressed electromotive force. A patent was immediately applied for on this invention, followed by other patents embodying various means of carrying out this principle in several types of meters. These patents were soon allowed and were most important in the art. The need of an induction-type watthour meter, accurate on low power-factor, was particularly emphasized at this time by the building of the Niagara Falls plant. It was here that the first Shallenberger-Westinghouse watthour meters, embodying quadrature of the shunt field, were used. All modern induction meters throughout the world embody this feature in some way, for otherwise they would be useless except on purely non-inductive loads.

Fig. 18. Duncan Fort Wayne alternating-current watthour meter of 1899.

Other pioneers in the induction-meter art, aside from a number abroad not of particular interest to us, were Scheefer, Duncan, Gutmann, and Stanley. The induction meters of these and other inventors were brought out in this country during the years 1894 to 1900. Of these meters the most interesting was the Stanley which embodied the then famous magnetic flotation for the moving system. The heavy permanent magnets which served as the control magnets for the moving system were so arranged in this meter that the aluminum disk, suspended on a steel shaft guided by a piano wire, literally *floated* in the gap space of the driving and retarding structures, and therefore had no bearings in the ordinary sense. The construction, while it had many advantages, was expensive and after a time gave trouble due to several causes. As a result, it has not survived in modern meters, as the reduction in weight of moving systems and improvements in lower bearings have made such complication unnecessary.

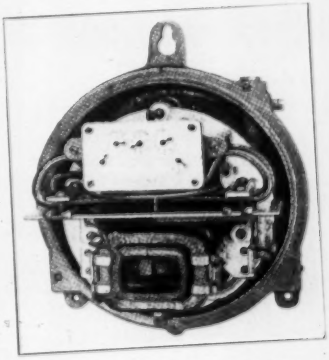


Fig. 19. Scheefer alternating-current watthour meter of 1898.

Induction-Meter Art now Standardized

By the year 1900 the alternating-current system of distribution, both polyphase and single-phase, was becoming more popular throughout the

world than direct-current systems, which at that time, in the United States, became confined principally to a few large cities and to traction work. The demand for alternating-current meters was therefore greatly stimulated and a number of manufacturers were engaged in making the several types of meters mentioned. However, from 1900 to 1904, patent litigation was carried on under the famous Tesla split-phase patents Nos. 511,559 and 511,560, which were owned by the Westinghouse Company with license rights to the General Electric Company. These patents, after long, bitter and expensive litigation were eventually sustained as covering practically all types of single-phase motors, and without question, motor elements of induction meters. From the early part of 1904 until the expiration of these Tesla patents in December, 1910, induction meters were made only by the owners and licensees of these

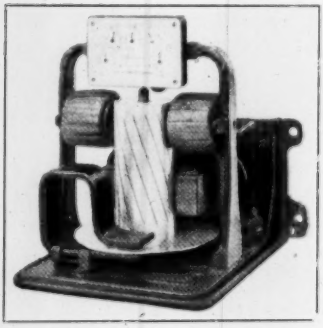


Fig. 20. Gutmann watthour meter of 1899 with cover removed showing cylindrical armature.

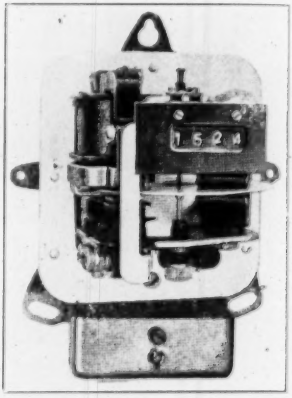


Fig. 21. The Siemens-Schuckert meter with cover removed.

patents. Naturally this resulted in the absence of incentive to other manufacturers and inventors in this art during the period mentioned with the result that further important development in the induction meter art were largely delayed until after 1910. The alternating-current meter art is now thoroughly standardized throughout the world, and while there are many types, both of single-phase and polyphase meters, all operate on the same principle—that is, of the Ferraris or Tesla rotating field. The various meters differ widely, however, in details of design, such as weight and form of moving system, upper and lower bearings, arrangement of retarding magnets, driving structures and registers. They also differ in power-factor, light-load and full-load adjustments, in losses and in torque.

New Instruments

Recently Developed by Instrument Manufacturers

Spindler & Hoyer Viscosimeter

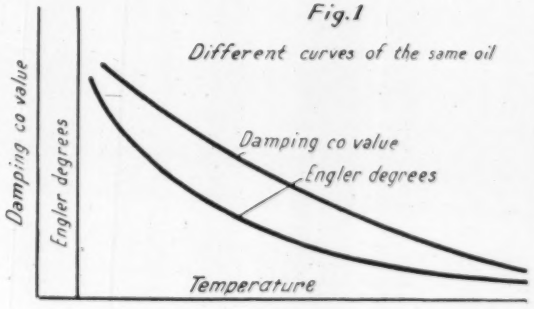
(Akatos, Inc.)

THIS viscosimeter registers automatically the damping of a pendulum which swings in oil. This damping is a measurement of the viscosity.

The new viscosimeter has the following advantages:

1. Greater accuracy.
2. Applicable within a very large viscosity range without interruption of measurement or cleaning of the instrument, respectively.
3. Time required for each measurement about 10 minutes.
4. Can be used for high temperatures (150° C and more).
5. Automatic registration of the curve thus eliminating possible errors of the observer.
6. The possibility of measuring impure or graphitied oils.

Fig.1



The pendulum-viscosimeter (Fig. 2) consists of a pendulum (a) with an adjustable weight (b). The pendulum is attached to beam (c), the latter being provided with adjusting screws (d) for regulating the time of oscillation. Above the beam (c) a frame is provided carrying the small ball (f) and the mirror (g). The ball emerges to a certain depth into the oil vessel (h). An overflow tube (i) provides for constant heights of the liquid when in case of warming the oil begins to expand. An electric heating device is built into the outer vessel (k) in order to make it possible to obtain any required temperature of the liquid.

The photographic film rolls off in a light tight case (1), the oscillation is registered automatically on the film in such manner that a light spot from lamp (m) with a diaphragm of small aperture (n) is projected through lens (o) in tube (p) by means of mirror (g).

The mirror, being permanently fixed to beam (c) makes all movements with pendulum (a), while the film is rolled off by means of a modified Morse apparatus (q) and driving cord (r).

The case (1) contains a table which flattens the film while gliding over it and which is provided with a pointed needle to draw the zero line on the film. The electro magnet (s) permits the pendulum to swing only from a given distance and assures accurate release.

Two special designed gauges are provided to measure and check the correct immersion depth of ball (f) in the liquid. The one is for measuring the distance between ball (f) and upper edge of beam (c) and the other for measuring the distance between the edge of the overflow tube and the upper edge of the beam. The temperature of the oil is taken with thermometer (t), the bulb of which is enclosed in a ball-like cover of 12.71 mm diameter and which causes the friction of the oil particles in the liquid. Thereby the temperature of the oil particles subject to

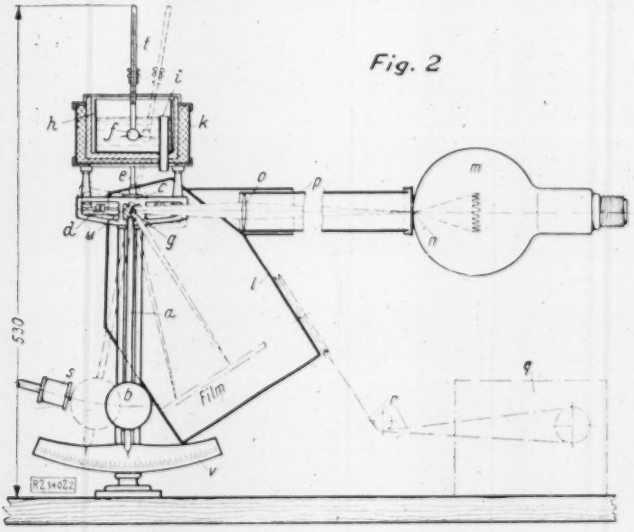


Fig. 2

friction during the oscillation of the pendulum is measured, and no error can occur in case temperature variations should exist within the oil bath. However same can be checked by using a second thermometer. Uniformity in temperature may be obtained by stirring the oil bath with the pendulum before taking measurements. The magnet (s) is adjusted in such way that the primary angle of oscillation is 10° for the vertical position of the pendulum. For the approximate determination of the de-

creasing angle of the pendulum during the oscillation following can be read from the degree scale (v) attached to the base of the center column.

The liquid to be examined is poured into the oil vessel (h) and brought to the desired temperature during which time the pendulum should swing in order to obtain uniform temperature throughout the oil vessel. The pendulum is then arrested by the electro magnet, the film driving mechanism is put in motion and the lamp switched on. The pendulum is released and the curve is taken to a certain (about 30°) angle of oscillation. The time of oscillation need not be calculated to obtain the damping co-value and therefore a possible uneven movement of the film does not cause any disturbance.

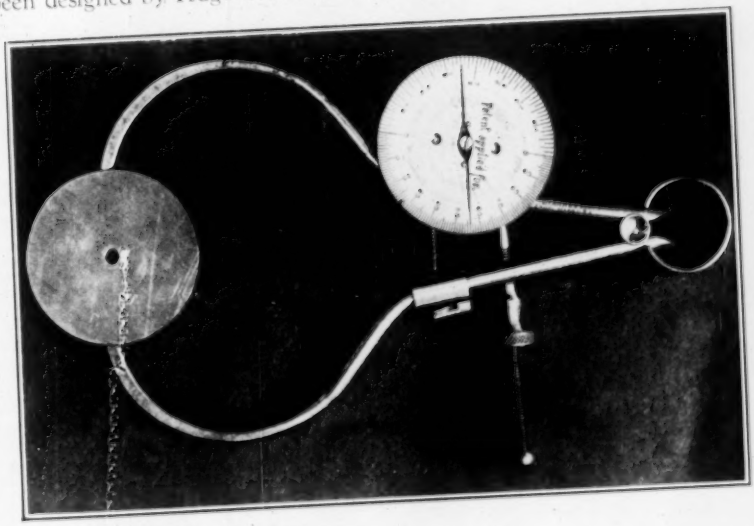
Photographic paper can be used instead of film when copies are not required. The film can be inserted in daylight.

The stage is provided with a pointed needle upon which the light spot must point when the pendulum is at rest, any deviation therefrom is adjusted by the mirror or can be later calculated when the measurements are made.

A sharply focused light spot on the film is obtained by displacing the large tube (p) with lens (o), the latter produces a sharply focused image of diaphragm (n).

A Convenient Indicating Device for Dividers, Calipers and Compasses

TO eliminate the tiresome and slow operation of taking measurements directly from a scale or rule, a novel and practical device has been designed by Hugo Semrau, Pittsburgh, Pa.



The illustration shows a pair dividers having slides to be clamped to its legs, a graduated disc is carried by one of the slides and a rotary pointer, mounted co-axial, which can rotate upon the disc. A drum is arranged to rotate with the pointer and a chain attached to the drum and to the other slide.

The dial is graduated in 1/64″ and 1/100″, half of the dial representing 1 in., is graduated in 64ths, the other half representing 1 in., graduated in hundredths; the double pointer revolving upon the dial, indicates on the one side of the dial fractions of an inch and on the other side the corresponding decimal equivalents.

The dial performs the function of a vernier, and when made of a suitable size, the graduation upon the dial being magnification of the actual distance.

For the enlargement or reduction of drawings, the instrument can be provided with a dial for the direct indication of any desired units, such as inches, centimeters, feet, yards, miles, kilometers, etc.

The application of this device is not limited to drafting compasses, toolmaker's dividers, and inside or outside calipers, but is also adapted to be used with any measuring fixture which requires accurate readings and quick manipulation.

———::———

In 1757, John Dolland, an English optician, invented the achromatic telescope by the combination of flint and crown glass.

John Frederick Daniell, a chemist of London, England, introduced the expansion pyrometer in 1822, using a platinum rod encased in plumbago and equipped with a device for moving a pointer over a scale.

In 1825, a pyrometer was invented by John Frederick Daniell, an English natural philosopher.

In 1826, Antoine César Becquerel, a French physicist, used various thermocouples to measure temperature, especially one of platinum and palladium.

A new pyrometer was developed about 1851 by Gauntlett, which consisted of two metallic rods or tubes, one inside the hot blast pipe and one in the cold air outside, the differential expansion actuating a pointer on a dial.

Sir Williams Siemens (1860) suggested that the variations in electric resistance with heat of a platinum wire could afford a pyrometric method. He actually used the method as a thermometer with copper wire.

Calorimetric pyrometers, based on Regnault's "method of mixtures," were first made for industrial purposes by Bystroem, who patented an instrument of this type in 1862.

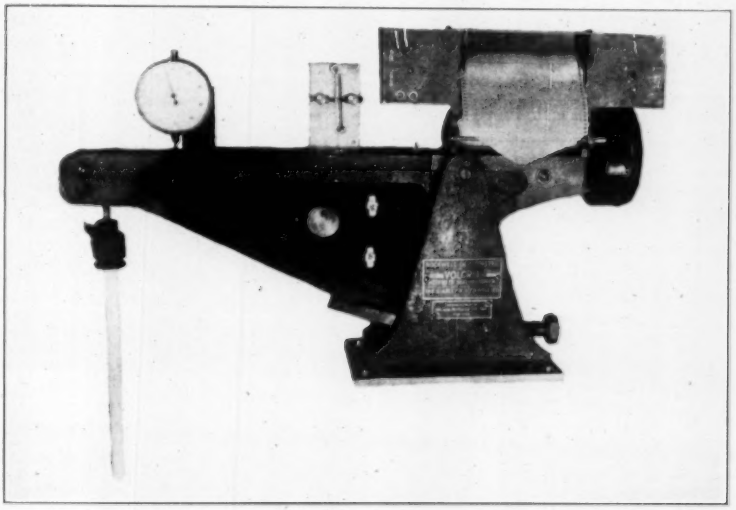
Pyrometers were not used in the United States to measure the temperature of Blast Furnaces until 1862, when Edward Brown, of Philadelphia, introduced an English pyrometer.

The Rockwell Dilatometer, With Panel Built Into Instrument

(Stanley P. Rockwell Company)

THE panel board holds a vibrator which can be used as desired dependent upon shop vibrations, light for automatically indicating critical range, bell for automatically indicating completion of critical range, and bell ringing transformer for direct connection to 110 or 220 volt line.

The knife fulcrum has been superseded in this model by the pivot fulcrum, giving greater accuracy with this instrument for calculations involving expansion.



By this method of construction the instrument is shipped so that it can be set up with a minimum amount of assembly without adjustment of any sort.

This instrument is designed for attachment to any stationary type furnace whose hearth is of a ceramic material and rigid. Various lengths of quartz feeler rods can be supplied depending upon furnace size. For extremely large furnaces the instrument may be mounted at a distance from the furnace and the motion of the work in the furnace transmitted to the Rockwell Dilatometer by a liquid transmission unit.

Current Literature Review

Abstracts on instruments of interest to instrument readers

Measurement of Concrete Materials. R. T. Giles, Can. Eng. Feb. 7, 1928, pp. 203-204.

Essential features in the mixing of concrete for road construction described in a paper presented at the Annual Convention of the American Road Builders' Association in Cleveland. Weighing method for fine and coarse aggregate is shown.—J. H.

Action of Pure Water on Cement Mortar Briquets. Engg. News-Rec. Feb. 9, 1928, pp. 236-237.

Abstract of an article from Le Génie Civil which gives the results of tests made in the laboratory of the Société des Chaux et Ciments de Lafarge et due Teil. Tests show disintegrating effect of distilled water, no change resulted from using river water.—J. H.

Electrical Methods of Geophysical Prospecting. J. J. Jakosky. Engg. Min. Jl., Feb. 11, 1928, pp. 238-244.

First installation of article gives a brief discussion of the fundamental factors underlying the operation of electrical methods for geophysical prospecting and geological subsurface investigations.—J. H.

The Martienssen Methane Detector. F. O. Willhofft. Min. & Met., Feb. 1928, pp. 66-68.

Description of a portable device for detecting the presence of methane in gaseous mines, which is as easily used by a novice as by an expert.—M. B. R.

Sensitivity and Period of Oscillation of Simple and Composite Scales. (Empfindlichkeit und Schwingungsdauer einfacher und zusammengesetzter Waagen). Max Raudnitz. V. D. Zeits., Jan. 14, 1928, pp. 50-53.

The dependence of sensitivity and the period of oscillation upon the shape of the beams, upon the position of the knife edges in the beams, upon the arrangement of the beams to one another as well as upon the load.—Ha.

Instrumental Works on the Nature of Glacier Motion. Rollin T. Chamberlin. Jl. Geology, Jan.-Feb. 1928, pp. 1-30.

Measurements of the internal shearing in glaciers were made with self-recording clockwork apparatus, in an endeavor to decide between viscous flow and crystalline yielding as the basic phenomenon in glacier motion. These automatic records show that slipping takes place along definite shearing planes, at times gradually and at other times by distinct jumps.J. H.

The Practical Side of Performance Testing of Aircraft. T. H. England. Jl. Royal Aero Soc. Jan. 1928, pp. 6-24.

The objects of performance testing are listed. The following tests are taken up: Partial Climbs, Climbs, Speeds, Speed Course, Stalling and Landing Speeds, Longitudinal Stability, Landing and Take-off Tests, Radiator Tests, Vapour Separation Test, and Petrol Consumption Tests. The importance of care of instruments is mentioned.—W. G. B.

A New Universal Long-Wave Radio Intensity Measuring Set. J. Hollingworth. Jl. Scient. Instr. Jan. 1928, pp. 1-9.

It is pointed out that the existing long-wave measuring apparatus has been found not sufficiently refined for the more complicated observations now required in the study of the polarization of radio waves; and a detailed description is given of a new apparatus for the purpose, which is primarily designed to measure in rapid succession the E. M. F.'s in 2 coils oriented in different directions to the arriving signal, and the phase angle between these 2 E.M.F.'s.—M. B. R.

Quartz-Metal Joints, and Their Application to Standard Air Condensers of Low Range. D. A. Oliver. Jl. Scient. Instr. Jan. 1928, pp. 9-14.

A relatively easy method of making quartz-metal joints is described. In the case of quartz rods or tubes, the ends are platinized and tinned. They are then inserted into special tinned sockets of simple form and the joint made with Wood's Metal. The application of such joints to the construction of high class air condensers of low minimum capacity is pointed out, and the design for a standard of approximately 50 microfarads range is given in detail.—M. B. R.

A Simple Method of Measuring Low Pressures. R. J. Clark. Jl. Scient. Instr. Jan. 1928, pp. 14-15.

A method of estimating very low pressures, which does not require anything but a McLeod Gauge, and is sufficiently accurate for rough work, is to pump the gases from the exhausted vessel into a McLeod Gauge, and measure the rate of increase of pressure therein.—M. B. R.

Additional Information on the Contraction of Steel Castings. (Beitrag zur Schwindung von Stahlguss) F. Koerber & G. Schitzkowski St. u. E. Feb. 2, 1928, pp. 129-134 and Feb. 9, 1928, pp. 172-178.

The practical importance of contraction. Changes in shape and crack formations due to differences in contraction. Contraction tests on Acid open hearth castings of simple rod rods. Con-

traction on Basic open hearth castings. Investigation of the hot crack formation in castings. Influence of chemical composition on the contraction of steel castings. Movements of large tooth and disc wheels during contraction.—C. W. K.

German Insulating Materials. H. Prehn. Plastics. Jan. 1928, pp. 15-18, Feb. 1928, pp. 69-71, 88.

Fundamental principles underlying manufacture of molded and laminated insulating materials as developed in Germany. Methods employed for testing the insulating materials and their general classification.—M. B. R.

A Simple Method of Determining Stress in Curved Flexural Members. Benjamin J. Wilson & John F. Quereau. Engg. Exp. Sta., Univ. of Ill. Circular No. 16.

The object of the investigation reported in this bulletin was to determine accurately values of the correction factor K, to be used with ordinary straight-beam formulas, for variously shaped sections and for degrees of curvature commonly found in curved flexural members, and thus to make available the results of the curved-beam theory without involving the usual difficulties and errors encountered in determining the value of Z and in using the more involved curved-beam formula.

The Absorption of Sound by Materials. Floyd R. Watson. Engg. Exp. Sta., Univ. of Ill. Bulletin No. 172.

The object of the investigation described in this bulletin was to determine experimentally the absorption coefficients for a number of materials for the information of architects and others interested.

Heat Transfer in Ammonia Condensers. Alonzo P. Kratz, Horace J. Macintire and Richard E. Gould. Engg. Exp. Sta., Univ. of Ill. Bulletin No. 171.

The principal object of the investigation reported in this bulletin was to determine the coefficient of heat transfer for the various types of condensers, regarding the total surface exposed to saturated ammonia vapor as a whole.

The Surface Tension of Molten Metals. Earl E. Libman. Engg. Exp. Sta., Univ. of Ill. Bulletin No. 173.

This bulletin contains the results of an investigation which was undertaken to secure information concerning the surface tension of molten metals.

The Effect of Climatic Changes Upon a Multiple-Span Reinforced Concrete Arch Bridge. Wilbur M. Wilson. Engrg. Exp. Sta., Univ. of Ill. Bulletin No. 174.

The object of the investigation reported in this bulletin was to observe the change that took place in a multiple-span arch bridge in order that the magnitude of the changes might be determined, and the measured and computed changes compared.

Causes of the Volume Changes which Accompany the Hardening of the Alloys of Aluminum and Copper. Pierre Chevenard & Albert Portevin. Comptes Rendus. Jan. 16, 1928, pp. 144.

A discussion of the volume changes which occur in a complex aluminum copper alloy as a result of ageing at various temperatures subsequent to quenching in water at 20° C from 525° C. The validity of the classical theory of ageing is questioned, it being shown that the simple precipitation of Cu_2Al_3 cannot account for the observed phenomena. It is shown that another phenomenon involving a diminution of volume occurs and it is suggested tentatively that it is due to the presence of impurities in or addition to the alloy. Further work is pending.—O. W. E.

The Dufour Oscillograph. Genie Civil. Jan. 21, 1928, pp. 75.

An abstract of a paper presented by E. Gondet before the Société Française des Electriciens on January 7, 1928. He describes improvements made in this oscillograph which have given it all the qualities requisite in an industrial apparatus. The apparatus allows of phenomena of the duration of the order of 10-6 seconds to be recorded. Its sensitivity is such that a deflection of 10 mm is obtained per milliampere and 20 mm per 100 volts. The apparatus involves the use of cathode rays which may be deflected either by a magnetic or an electric field according to the measurements required, the rays being received on and impressing their image upon a sensitized plate or paper.—O. W. E.

The Deep Etching of Steel. (L'essai de corrosion des aciers.) Genie Civil. Jan. 28, 1928, pp. 90.

A review by P. C. of a new book by Ch. Frémont on the deep etching of steel. The value of the macrographic examination of iron and steel is emphasized and instances of its use in practice are referred to.

Apparatus for Removing Samples of Liquids from Rivers and Canals. Genie Civil. Jan. 21, 1928, pp. 78.

This apparatus, which was devised in connection with experiments in Dock de la Plate, is described in detail in the Bulletin de Obras publicas de la Republica Argentina, for September, 1927, by R. Stilo Rigoli. It has been finally established that it is possible to take quite large samples at a definitely measured depth, by means of a very sturdy apparatus, which at the same time affords ample security. The apparatus consists of a cylinder mounted on a hollow cane furnished with a handle; between the cylinder and the cane is a filling valve, which is worked from the upper part of the apparatus by an eccentric handle, through the medium of a rod passing down the inside of the cane. A mark on the outside of this allows the depth to which it is set to be noted and 2 valves secured to the bottom and top of the cylinder respectively serve at the same time to insure the tightness of the apparatus and the discharge of the liquid sample. The openings for filling are fixed so that entry of the water into the cylinder may proceed without the formation of any such eddys as might interfere with the regular flow of the stream of water

Information Section

Correspondence from instrument users and others pertaining to or relative to instruments

THIS section invites correspondence from instrument users and others relative to questions pertaining to instruments. If our own editorial staff should feel that any question submitted cannot be readily answered, we will obtain the necessary information from some of our collaborators. Thus the greatest experts are at the disposal of our readers in assisting them in the solution of their instrument problems.

Names and addresses of manufacturers of instruments will be furnished on special request. Inquiries pertaining to sources of supply should be addressed in writing to our Information Section. Such inquiries will be answered promptly by mail.

Inquiries regarding instrument problems will be answered by publication in this special "Information Section" of INSTRUMENTS. We feel that other besides the inquirers may be interested in the same or similar problems, and in this way all of our readers will obtain the benefit of the information furnished.

No. 1. We are at the present time looking for an instrument for detecting noises in ball bearings. We are wondering if you have any information in your files about concerns which make instruments, which could be used on a production basis, for detecting noises in bearings?—V. W. F.

No. 2. Can you put us into communication with the manufacturers of the Howard-Dolman Depth Measurement Instrument?—E. F. H.

No. 8. Can you give us the name of any concern that could supply us with a jump spark coil that would give a spark 24 inches long? The coil should operate on a storage battery with six or twelve volts.—A.A.D.

No. 9. Kindly furnish me with reference for an electrical instrument for detecting water leaks.—L. L. T.

No. 10. We have at our plant a fatty acid still and would like to have you furnish us information as to where we can get an instrument or apparatus that will show the liquid height inside the still. The operating conditions of this still makes it difficult to install a device that will show the liquid level. This still is 10 feet in diameter, about 15 feet high, cast iron, directly fired and operating with 25 to 27″ vacuum.—E. M. N. Jr.

No. 11. We have been trying for some time to find a meter which will accurately measure the oil going to the burners in our kilns. These burners use about six or eight gallons of oil per hour and the oil is fed to the burner through a one-half inch pipe, under a pressure of 300 pounds per square inch.—G. E. S.

No. 12. Can you give us the names of the manufacturers of a hardness testing instrument which can be used to test a cylinder of 10-inch diameter or larger.—J. C. B.

into the side where the sampling is done. The various parts of the apparatus are made of brass with the exception of the cylinder which is made of galvanized iron. O. W. E.

Additional Information on the Theory of the Refractometer. (Zur Theorie der Refraktometer) Hans Schulz. Zs. Instrument. Jan. 1928, pp. 26-30.

A theoretical discussion.

Several Observations on Box Levels. (Einige Beobachtungen zu Dosenlibellen) Karl Luedemann. Zs. Instrument. Jan. 1928, pp. 31-39.

Results are shown.

Special Arrangements for Observing the Position of Box Level with Levels. (Besondere Vorrichtungen zum Beobachten des Libellenstandes bei Nivellierinstrumenten) P. Werkmeister. Zs. Instrument. Jan. 1928, pp. 39-40.

An arrangement for observing the position of the bubble is described.

The Investigation of a Breithaupt Circle According to the Method of Heuvelink and Remarks on this Method of Investigation. (Untersuchung eines Breithauptschen Kreises nach der Methode von Heuvelink und Bemerkungen zu dieser Untersuchungsmethode) L. Fritz and W. Uhink. Zs. Instrument. Feb. 1928, pp. 53-68.

The errors in circle divisions is investigated and the results are given.

The Determination of Circle Division Errors. (Zur Bestimmung von Kreisteilfehlern) A. Bohrmann. Zs. Instrument. Feb. 1928, pp. 69-70.

The methods of Heuvelink and Bessel are considered.

The Determination of Lens Radii. (Zur Messung von Linsenradien) A. Schleiermacher. Zs. Instrument. Feb. 1928, pp. 70-74.

Two methods were investigated and compared by the author. He found both methods to give satisfactory results.

Tests of the Manufacture of Resistant Weights. (Versuche der Herstellung widerstandsfachiger Gewichte. A. N. Schuckarew. Zs. Instrument. Feb. 1928, pp. 88-90.

The difficulties experienced with gold plated weights are listed. The attempt to overcome these difficulties by the use of quartz weights was not successful. The advantages of the platinum weight as a standard is mentioned but the difficulty is high price. The author devised a weight made of a platinum or platinum-iridium shell filled with a cheaper metal. The method of adjusting the weights is described.

A Modification of the Michelson Interferometer. R. M. Langer. Jl. Opt. Soc. Feb. 1928, pp. 134-136.

The method of constructing the device is given and the advantages are listed.

Some Applications of Spark Photography. D. B. Woodbridge and A. E. Parker. Jl. Opt. Soc. Feb. 1928, pp. 125-133.

The advantages of spark photography as an analytical method for the examination of various phenomena are mentioned. Illustrations show the method and results obtained with a ping-pong ball on a jet of air and water, a falling stream of water, and steel ball falling through a soap film.

A Recording Photoelectric Spectrophotometer. Arthur C. Hardy and Frederick W. Cunningham. Paper read before the annual meeting of the Opt. Soc. of Amer., Oct. 1927.

This instrument has been designed primarily for the rapid measurement of the color of reflecting surfaces. The specimen to be measured and a piece of magnesium carbonate are illuminated from opposite sides of a ribbon filament tungsten lamp. Beams of light from the specimen and from the magnesium carbonate are alternately admitted to the slit of the dispersing system. Before reaching the slit, both beams traverse symmetrical paths except that one beam is reflected at a second-surface silvered mirror. After passing the slit, both beams traverse the same path. A photoelectric cell receives light from a small fraction of the spectrum produced by the dispersing system.

When the two beams are of unequal intensity, an alternating current is generated in the photoelectric cell. This current is amplified by photrons and rectified by a synchronous commutator. The rectified current operates a galvanometer relay which controls a reversing motor. This motor controls a diaphragm which varies the illumination on the magnesium carbonate, and automatically equalizes the intensities of the two beams.

A pencil operated from the mechanism controlling the diaphragm draws a trace on a rotating drum. The rotation of this drum is used to change the wave length of the light admitted to the photoelectric cell. Thus the instrument automatically plots the spectro-photometric curve rapidly, and with a precision exceeding that of visual instruments.

The X-Ray Examination of Materials. George L. Clark. Heat Treating and Forging. Feb. 1928, pp. 138-145.

The article is abridged from a paper given before the American Society of Testing Materials. It takes up: Apparatus, Nature of the X-Ray, Current Uses, Analysis of the Structure of Materials, Methods of Study and Types of Information Gained—Crystallographic Patterns.

Tests in Locating Faults of Treatment. John D. Gat. Heat Treating and Forging. Feb. 1928, pp. 146-149.

Means for Differentiating between faults due to incorrect treatment and those traceable to steel quality are described. The causes of failure are given, also their correction.

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Cylindrical and Thread Plug-Gages. Jl. S. A. E. Jan. 1928, pp. 24-26.
Recommendations of an independent committee offered for the approval of the society.

Locomotive Tests at Purdue. Railway Journal. Jan. 1928, pp. 18-19.
Tests being made by American Railway Association and Purdue University described. Half of tests completed. Trainagraph which records braking time and air pressure mentioned.

Fatigue Tests of Carburized Steel. H. F. Moore and N. J. Alleman. Trans. A. S. S. T. March 1928, pp. 405-419.
This paper presents the results of fatigue tests and of static tension tests of carburized steel. Three steels were studied; a plain carbon, a nickel steel, and a chromium-nickel steel. Several different treatments were tried for each steel. In general, the test results suggest that carburizing, followed by suitable heat treatment, is a promising means of increasing the fatigue strength of steel as well as an effective means of increasing surface hardness. Steel quenched in oil from the carburizing pot showed more increase in fatigue strength than did steel cooled in the carburizing pot.—C. W. K.

High Speed, High Voltage X-Ray Diffraction Analysis of Metals. Dr. Ancel St. John. Trans A. S. S. T. March 1928, pp. 485-492.
A quick and convenient method of X-Ray diffraction analysis has been developed. It is a modification of the usual "pinhole" method using tungsten radiation at 200,000 volts as in radiographing castings, so that a powerful beam passes through ½" steel. If desired, entire sheets or formed articles can be mounted in the instruments or specimens can be cut without affecting the portion to be examined. Exposures of 2 hours or less are sufficient. The method has been applied to brass, tin and steel in the study of mechanical working, heat treatment, extrusion, aging and the effect of exposure to gases. Radiographic examination of steel and brass castings for high pressure service has been carried on simultaneously. Some typical results are illustrated.—C. W. K.

A Comparator-Microphotometer. George R. Harrison. Jl. Opt. Soc. Jan. 1928, pp. 63-67.
This article describes a comparator-microphotometer, developed by the author for making intensity measurements in complex spectra, where the lines are found so closely packed that they are not sufficiently resolved except with the highest dispersion and a very narrow slit.

A Universal Spectrophotometer. J. W. Forrest. Paper read before the annual meeting of the Opt. Soc. of Amer. Oct. 1927.
The report described a new spectrophotometric arrangement designed to be universal in its application. A sphere was used to provide for the illumination of opaque bodies. When measurements on transparent bodies are to be made, the sphere may be replaced by a lamp house giving direct illumination.
With the need of the dye industry in mind an attachment was designed which provides for liquid columns easily and quickly adjustable in length.

Radio Direction Finding. L. A. Hyland. Aviation. Jan. 2, 1928, pp. 30-33.
Aims of radio direction finding is to direct aircraft along dark airways, to determine accurately limits of airport and to effect landing regardless of visibility. Rotating coil compass found not suitable. Radio compass valuable on isolated routes. Comparison of three types of direction finders.

Two Watt Meter and Three Watt Meter Circuits in the Blind Use of Meters. (Zweiwattmeter-und Dreiwattmeter-Schaltungen bei Blendverbrauch-Zachlern) R. Braunbeck. A. E. G. Metl. Jan. 1928, pp. 26-29.
The occurrence of the various circuits for the blind use of meters in alternating current nets are explained and illustrated. The advantages possessed by the A. E. G. Blind Meter when using two watt meter and three watt meter circuits in comparison with other circuits using a blind meter.

Precision Measurements in the Machine Shop. (Praezisionsmessungen im Maschinenbau) Max Kurrein. Messtechnik. Jan. 22, 1928, pp. 1-6.
The conception of precision measurements is taken up more specifically. The extent of their use on examples from the various spheres of the machine and apparatus construction is explained. A precise measurement can not be considered relative to the size of the piece, but depends upon the absolute measurement accuracy.

The International and the Absolute Electrical Units and Their Relation to One Another. (Die internationalen und die absoluten elektrischen Einheiten und ihre Beziehung Zueinander)—Wilhelm Jaeger. Messtechnik. Jan. 22, 1928, pp. 6-9.
General information on the absolute and international electrical units. The use of the international units with practical electrical and magnetic measurements. The absolute electrical units and measuring system. The empirical international electrical units. The numerical relation between the absolute and the international units.

New Arrangements and Methods for Microscopy with Incident Light (Neuere Anordnungen und Verfahren fuer die Mikroskopie im Auffallenden Licht) F. Hauser. Messtechnik. Jan. 22, 1928, pp. 9-13.
New forms of the Lieberkuehn mirror. A Lieberkuehn mirror according to the principle of the Mangin mirror. An oil immersion lens mounted in glass with arrangements for external illumination. Dark field reflector for external illumination. New types of vertical illuminators. Instruments for observation with incident and transmitted light. Microprojector for the measurement of Brinell hardness impressions.

The Laws of Error with Length Measurements. (Die Fehlergesetze der Laengenmessung) Prof. Klasmer. Zs. Vermess. Feb. 15, 1928, pp. 97-110.

Readers' Comments

It was my good fortune to see the February issue of your publication and you are to be congratulated, not only for covering the field of instruments, but for the clever manner in which the magazine is built.

Please enter the name given below for this year's subscription and let begin with the January issue as the whole volume is desired. If you expect to have bound volumes please put my name on the list for one.

Very truly yours,

George B. Hogaboom.

I recently subscribed to "INSTRUMENTS" asking that my subscription start with the first number. The second number has been received, but to date I have not received the first number, and I am anxious to have a complete file of this magazine.

In this connection I might say that "INSTRUMENTS" is the first magazine that I have met that is of some real benefit to the practical man who has to actually handle instruments. I am speaking with a background of thirty years experience and all the magazines that I have seen in the past were so involved in mathematics or so sketchy that you know very little about the instrument itself after having read the article. You seem to have hit the happy medium between these two extremes and by means of footnotes you have made it possible for any person who desires to make a further study of a particular instrument an opportunity to do so.

Yours truly,

J. S. Cruckshank, Superintendent,
Consolidated Gas Electric Light & Power,
Baltimore, Maryland.

Check for two dollars ($2.00), enclosed for my subscription. The first volume strikes me to be an excellent beginning. At last may we feel that we have a real instrument journal? One that will take hold of the important activities with vigor and sincerity; that will get full confidence and support of the many who are concerned in tools and instruments; one that will in short take the bull by the horns and ramble in this wide and useful field.

Very truly yours,

Enoch Karrer,
Ph.D., Physicist Physical Research Lab.,
The B. F. Goodrich Company,
Akron, Ohio.

I have delayed answering your letter of February 16, 1928, until I received the copy of "INSTRUMENTS," which you stated was being sent to me. It has not yet arrived, but I am sure all the officers of the Coast and Geodetic Survey will welcome another magazine on instruments. This field is very poorly covered by publications in English and I have frequently heard expressed in the Coast and Geodetic Survey the belief that there is a real demand for a good periodical on the subject. I shall be glad to do everything I can to suggest to authors of articles suitable for your magazine that they submit them to you.

Very truly yours,

C. L. Hodgson, Assistant Chief,
Division of Geodesy,
Department of Commerce,
U. S. Coast and Geodetic Survey,
Washington, D. C.

Equations and graphs are given which represent the relation of the error on repeated measurement.

A New Magnetic Normal Theodolite. (Ein Neuer Magnetischer Normaltheodolet) R. Bock. Zs. Instrument. Jan. 1928, pp. 1-14.

A magnet theodolite here described and illustrated, in addition to making the ordinary observations of horizontal intensity for the extensive investigation of magnets, should determine exactly their parameter.

The Influence of the Mass of the Spring on the Dynamic Properties of Engine Indicators. (Der Einfluss der Federmassen auf die dynamischen Eigenschaften von Indikatoren) Otto Holm. Zs. Instrument. Jan. 1928, pp. 14-26.

The natural periods of cantilever and spiral springs are calculated and compared. It is shown that dynamically they are approximately equal.

An Electrical Solution-Mixing Device. K. Hickman and D. Hyndman. Ind. Engg. Chem. Feb. 1928, pp. 213-216.

Electrical titration methods in general use, employ electrodes immersed in the reacting liquids and give indications of hydrogen or other ion concentrations. The indications have been used by various workers to control automatically the mixing of two reagents. Such electrical controls may be described as operating internally. The present method uses external gaseous indicators such as sulphur dioxide or ammonia which it detects by an "electric nose" placed over the reacting vessel. The variations in current actuate a valve, which limits the particular solution in excess at that moment. The device is useful both in acidimetry and in oxidation-reduction reactions, particularly with complex mixtures, since only the chosen volatile constituent can affect the control. —M. E. H.

A Hardness Tester for Rubber. Erle C. Zimmerman and R. W. Brown. Ind. Engg. Chem. Feb. 1928, pp. 216-218.

Several instruments constructed to measure the hardness of vulcanized rubber are shown and described. These various forms led to the development of the improved form of penetrometer, portable or mounted, by means of which fifteen tests per minute can be made.

Measurement of Surface Temperature. D. F. Othmer and H. B. Coats. Ind. Engg. Chem. Feb. 1928, pp. 124-128.

Methods for attaching thermocouples to heating surfaces by mechanical means may give rise to satisfactory results, but may also give very erratic results. If the junction is formed by plating a layer of the second metal on the surface whose temperature is to be studied, and if the leads are attached before plating so that they are imbedded in the plate, uniform results are obtained. Directions are given for making nickel-copper junctions on tubes.—M. E. H.

Value of the Rubber Hydrocarbon in Reclaimed Rubber. W. W. Vogt. Ind. Engg. Chem. Feb. 1928, pp. 140-143.

Tire-tread stocks containing reclaim were so compounded that their ultimate composition was the same except for the percentage of reclaimed-rubber hydrocarbon substituted for new rubber hydrocarbon. Cures were adjusted to give the technical optimum in the same time of cure. The cured stocks were subjected to tensile and abrasion tests by five methods. Diagrams and descriptions of the abraders and methods of use are given.—M. E. H.

A Modified Weighing Pipet. Graham Edgar. Ind. Engg. Chem. Feb. 1928, p. 158.

A modified Lunge weighing pipet whereby duplicate or triplicate weighings of nearly the same quantity of material may be conveniently made, is shown in diagram.—M. E. H.

Explosive Properties of Lacquer-Solvent Vapors. E. G. Richardson and C. R. Sutton. Ind. Engg. Chem. Feb. 1928, pp. 187-190.

The range of vapor concentrations in air which are explosive have been determined for a number of typical lacquer solvents. The apparatus used in determining the explosive limits is shown in diagram.—M. E. H.

Brittleness Tests for Rubber and Gutta-Percha Compounds. G. T. Kohman and R. L. Peek, Jr. Ind. Engg. Chem. Jan. 1928, pp. 81-83.

An insulating material compounded of rubber, gutta-percha, or similar substances becomes brittle at a temperature characteristic of the material, below which it may not be used if liable to mechanical stress. An apparatus has been designed for determining this temperature by giving the sample a sharp bend through a fixed angle. The highest temperature at which fracture occurs in this test (the brittle temperature) has been found to be nearly independent of the bending angle and the sample's dimensions provided the rate of bending is maintained at a nearly constant (high) rate. A modified form of the apparatus is also described with which the brittle temperature may be determined when the material is under high hydrostatic pressure. The constancy of the brittle temperature when determined under different conditions suggests that it marks a change in the structure of the materials.—M. E. H.

A Simple Continuous Reading Method of Electrometric Titration with Bimetallic Electrodes. N. Howell Furman and E. B. Wilson, Jr. Jl. Amer. Chem. Soc. Feb. 1928, pp. 277-283.

A simple, direct reading and inexpensive system for determining end-points of oxidation-reduction reactions is described and a diagram given. The method depends upon the sudden change at the end-point in the potential difference between a platinum and a tungsten electrode which are immersed in the solution.—M. E. H.

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UNDOUBTEDLY the catalogues of a decade or so ago lived up to the strict dictionary definition "a list of things." Today, however, a catalogue is the result of no small effort and expense on the part of the manufacturer, who sets forth the merits of his product in such a manner that the public is made to recognize all its good points. Details of manufacture and operation of the instrument are given in considerable detail. It is a learned mind, indeed, that cannot derive some information from this type of literature. As a matter of fact, few books can be purchased where the information contained therein is more up-to-date than that found in the average catalogue.

In this section will be listed each month the new catalogues published during that time by the various instrument companies, who place such information at the disposal of the editor. Only such catalogues or bulletins should be requested as will be of direct interest to the individual making the request. When the catalogue or bulletin is received it should be carefully filed or afforded the protective accommodation of a book shelf. It will then be available for ready reference at all times and avoid a request for duplicate copies.

Accurate Control of Kiln Temperature

The Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., has issued circ. 27-P-12-228 with the above title, briefly illustrating the use of their indicators, recorders and control.

Aeronautical Instruments

Pioneer Instrument Company, 754 Lexington Ave., Brooklyn, N. Y., have issued a folder "Pioneer Instrument Boards" which shows an instrument board with the various instruments mounted on it.

Bakelite

"Doing the Unusual" is the title of a leaflet recently issued by the Bakelite Corporation, 247 Park Avenue, New York, N. Y.

Binocular Tube Attachment

The Zeiss Binocular Tube Attachment with inclined eyepieces is the subject of Catalog Mikro 412, issued by Carl Zeiss, Inc., 485 Fifth Ave., New York, N. Y.

Business Chemistry

A recent issue of the above house organ of Skinner, Sherman & Esselen, Inc., 246 Stuart Street, Boston, Mass., has a very interesting article "Acres of Black Diamonds," depicting the discovery of coal for heating purposes.

Combination Binocular and Monocular Body

Catalogue M-27 of the Spencer Lens Company, Buffalo, N. Y., describes and illustrates the new Spencer combination binocular and monocular microscope body. Prices are also given.

Combustion Compass

The "Combustion Compass" is the title of a recent direct mailing of The Hays Corporation, Michigan City, Ind. This describes the new Hays Test Set, which consists of Flue Gas Analyzer, Flue Gas Thermo-Gage and Draft Gage compactly arranged in an oak carrying case.

Circular Dividing Machines—Automatic

The various automatic dividing machines manufactured by Gustav Heyde, Kleist Str. 10, Dresden, Germany, are illustrated in a number of leaflets recently issued by this company with the title "Selbsttatige Kreis-Teilmaschine."

Frequency Recorder

The new improved Esterline-Angus Frequency Recorder for recording frequency to the accuracy required for synchronizing plants and interconnecting systems is described in Bulletin 1227 issued by The Esterline-Angus Company, Indianapolis, Indiana.

General Radio Experimenter

The February issue of this publication sent out by the General Radio Co., Cambridge, Mass., contains the following articles: "Equipment of the Service Laboratory," "Temperature Coefficient in Resistance Materials," "The Impedance Transformer."

Ground Resistance Tester

Bulletin 1165 recently issued by James G. Biddle, 1211 Arch Street, Philadelphia, Pa., describes the new "Megger" Ground Resistance Tester, a direct-reading electrical instrument for testing the resistance to earth of ground connections.

Hot Water Meters

A recent leaflet of the Buffalo Meter Company, 2917 Main Street, Buffalo, N. Y., describes their Niagara Hot Water Meters.

Hydrometric Instruments

Modern Hydrometric Instruments is the title of a book (Price List 115) issued by A. Ott, Kempten, Bavaria, Germany. The book is printed in English and covers the current meters, water level recorders and iron water gauge, scales manufactured by this company.

Interferometers

The various Zeiss Industrial Interferometers are described in Bulletin Mess 320 IV, issued by Carl Zeiss, Inc., 485 Fifth Ave.,

New York, N. Y. The following instruments are taken up: 1. Laboratory Interferometer; 2. Portable Interferometer for Gases; 3. Fire Damp Tester; 4. Interferometer for Liquids; 5. The Combined Gas and Water Interferometer. A chapter is also devoted to the use of the interferometers and the Fire Damp Tester.

Laboratory Microscopes

The Spencer Lens Company, Buffalo, N. Y., have described their laboratory microscopes in Bulletin M-29.

Lab-Rette

The Lab-Rette is used for making an approximate analysis of feed and boiler water and for checking the water conditions which should be maintained. The following determinations can be made: 1. Hardness; 2. Chlorides; 3. Sodium Phosphate; 4. Alkalinity; 5. pH value (approx.); 6. Dissolved Oxygen; 7. Total Dissolved Solids (approx.) This bulletin is issued by the Babcock & Wilcox Company, 85 Liberty Street, New York, N. Y.

Microscope

The new Stand E microscope is illustrated in Micro 411 issued by Carl Zeiss, Inc., 485 Fifth Ave., New York, N. Y.

Oil Meters

Niagara Oil Meters are described in a recent booklet of the Buffalo Meter Company, 2917 Main Street, Buffalo, N. Y.

Optical Pyrometers

A recent direct mailing of the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa., covers Optical Pyrometers for colleges.

Planimeters and Pantographs

Lists 301 and 401 issued by A. Ott, Kempten-Allgaeu, Germany, illustrates the planimeters and pantographs manufactured by this company. The booklet is printed in German.

Polarizing Apparatus

Catalogue 1 c issued by Akatos, Inc., 114 Liberty Street, New York, N. Y., describes the Franz Schmidt & Haensch Polarizing Apparatus for use in sugar plants.

Polarimeters

The Franz Schmidt & Haensch Polarimeters with graduated circles and accessories are taken up in Catalogue 1a issued by Akatos, Inc., 114 Liberty St., New York, N. Y.

Price List—Spencer Lens Company

Spencer Lens Company, Buffalo, N. Y., have issued their corrected price list of Microscopes, Microtomes, Delineascopes and Accessories dated February 1, 1928.

Price List—A. Ott

A. Ott, Kempten, Bavaria, Germany, has issued Price List No. 170 to cover the Ott Meter V.

Potentiometers for Temperature Control in Oil Refining

Bulletin No. 870 recently issued by the Leeds & Northrup Company, 4901 Stenton Ave., Philadelphia, Pa. This bulletin discusses the importance of temperature measurements in the oil refinery and illustrates the various instruments manufactured by them for this purpose.

Temperature Recorder

A new temperature recorder developed by Dr. Rudolf Hase, Hannover, Germany, is described in recent literature issued. This leaflet printed in German.

Spectrograph

The large quartz spectrograph for taking Photographs of the invisible range and the universal spectrograph for observation and photographing the visible and invisible range are covered in recent literature issued by Akatos, Inc., 114-118 Liberty Street, New York, N. Y.

Steam Meters

"Says the Accountant" is the title of a recent direct mailing of the Republic Flow Meters Company, 2240 Diversey Parkway, Chicago, Ill.

Strain Tester for Glass

The new Franz Schmidt & Haensch Strain Tester for Glass is described in literature issued by Akatos, Inc., 114 Liberty Street, New York, N. Y.

Stroborama

The Stroborama is described in a booklet entitled "The Analysis of Motion." The booklet was issued by Musa-Hattzell-Ducasse, Inc., 25 West 43rd Street, New York, N. Y.

Thermostatic Control

A new loose leaf catalogue recently issued by The Powers Regulator Company, 2720 Greenview Ave., Chicago, Ill., is entitled "Powers Thermostatic Control for Industrial Processes." This bulletin shows a most complete line of temperature controlling apparatus but does not cover the output of this company as they are constantly called upon to devise special control equipment for unusual industrial purposes.

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REGULATOR SYSTEM. Wm. E. Menzies, Irwin, Pa., assignor to Westinghouse Electric & Mfg. Co. Pat. No. 1,657,513.

MEASURING INSTRUMENT. Harry Y. Norwood, Rochester, N. Y., assignor to Taylor Instrument Co. Pat. No. 1,657,805.

APPARATUS FOR MEASURING LIQUID FUEL. August Nagel, Stuttgart, Germany. Pat. No. 1,657,838.

ELECTRICAL INDICATING INSTRUMENTS AND CONTROL SYSTEM THEREFOR. Hugh L. Decker, Toledo, Ohio, assignor to The W. G. Nagel Electric Co. Pat. No. 1,657,855.

LIQUID MEASURING VALVE. Jesse D. Langdon, Los Angeles, Calif. Pat. No. 1,658,000.

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SPEEDOMETER TESTING DEVICE. John Lillyquist, Chicago, Ill., assignor to Stewart-Warner Speedometer Corp. Pat. No. 1,658,055.

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PRESSURE DIFFERENCE MEASURING INSTRUMENT. Max Weiss, Berlin-Friedenau, Germany, assignor by mesne assignment to Bailey Meter Co. Pat. No. 1,658,699.

ELECTRICAL MEASUREMENT INSTRUMENT. Raymond T. Pierce, East Pittsburgh, Pa., assignor to Westinghouse Electric & Manufacturing Co. Pat. No. 1,658,902.

WEIGHING AND MEASURING MACHINE. Austin J. Ruppert, Forreston, Ill. Pat. No. 1,658,943.

TIME-CONTROLLING DRIVING MECHANISM FOR RECORDING SURFACES. William Cooper Sutherland, Keighley, England, assignor to Work Meters, Limited. Pat. No. 1,659,336.

MANOMETER. Fairleigh S. Dickinson and Andrew W. Fleischer, Rutherford, N. J., assignors to Becton, Dickinson & Co. Pat. No. 1,659,393.

INDUCTION ELECTRICITY METER. Jesse Harris, LaFayette, Ind.; assignor to Duncan Electric Manufacturing Co. Pat. No. 1,659,429.

BOILER FEED REGULATOR. Merrill G. Benjamin, Lakewood, Ohio, assignor by mesne assignment to Bailey Meter Co. Pat. No. 1,659,552.

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TENSION-MEASURING DEVICE. Alfred Marchew, Cicero, Ill., assignor to Western Electric Co. Pat. No. 1,659,919.

LENS GAUGE. Nelson M. Baker, Southbridge, Mass., assignor to American Optical Co. Pat. No. 1,659,969.

TEMPERING, MEASURING OR WEIGHING MECHANISM. Paul S. Ward, Cincinnati, O., assignor to Triumph Manufacturing Co. Pat. No. 1,660,110.

TURN INDICATOR. Charles H. Colvin, Brooklyn, N. Y. Pat. No. 1,660,152.

TESTING MACHINE. Dunlap P. McAdams, Jr., Annapolis, Md., assignor to Tinius Olsen Testing Machine Co. Pat. No. 1,660,270.

VOLTAGE REGULATOR WITH THERMOSTATIC COMPENSATOR. Anton Frank Brotz, Kohler, Wis., assignor to Kohler Co. Pat. No. 1,660,322.

HIGH-FREQUENCY MEASURING SYSTEM. Herman A. Affel, Maplewood, N. J., assignor to American Telephone & Telegraph Co. Pat. No. 1,660,405.

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DUAL THERMOSTAT. John H. Swan, Chicago, Ill. Pat. No. 1,660,586.

LIQUID METER. Alfred Monard, Paris, France, assignor to Société L'Aster. Pat. No. 1,660,623.

THERMOSTATICALLY CONTROLLED FLUID VALVE. Clarence M. Updegraff, Washington, D. C. Pat. No. 1,660,637.

METER AND THE LIKE. Thomas A. Banning, Jr., Wilmette, Ill. Pat. No. 1,660,641.

WEIGHING SCALE. Louis A. Osgood, Hartford, Conn., assignor to Toledo Scale Company. Pat. No. 1,660,681.

TESTING DEVICE. Edward G. Thomas, Toledo, Ohio, assignor to Toledo Scale Co. Pat. No. 1,660,691.

TESTING DEVICE. Edward G. Thomas, Toledo, Ohio, assignor to Toledo Scale Co. Pat. No. 1,660,692.

THERMOSTATIC CONTROL DEVICE FOR WATER HEATERS. John G. Wragg, New London, Conn. Pat. No. 1,660,776.

ELECTROMAGNETIC DEVICE. John S. Gatvin, Bogota, N. J., assignor to Western Electric Company. Pat. No. 1,660,994.

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GAS METER MECHANISM. Wilford A. Gaugh, Erie, Pa., assignor to The American Meter Co. Pat. No. 277,991.

GASOLINE LEVEL INDICATOR. Cecil David James and Alfred T. Bate, coinventors, Strathroy, Ontario. Pat. No. 278,045.

ELECTRICAL TESTING INSTRUMENT. James Knox Elderkin, assignor to The Forest Electric Corp. Pat. No. 278,173.

THERMOSTAT. Frederick William Robertshaw, Pittsburgh, Pa., assignor to The Robertshaw Thermostat Co. Pat. No. 278,192.

HYDROCARBON OIL TESTING APPARATUS. Frank B. Mason, New Providence, N. J. Pat. No. 278,221.

BRITISH PATENTS

Printed Copies of the Specifications in the following list can be secured by addressing the Patent Office Sale Branch, 25 Southampton Building, Chancery Lane, W. C. 2, London, England.

GAS METERS. A. M. Knauer, J. Elster, L. Goertz, E. Haas-Weichelt and P. Haas, 31 Rheinalle, Mainz, Germany. Pat. No. 281,673.

ELECTRIC MEASUREMENTS. H. Dember, Doelzschen, Germany. Pat. No. 281,677.

THERMIONIC VALVES. Westinghouse Lamp Co., Bloomfield, N. J., (assignees of W. C. Sproesser, 220 Springdale Ave., East Orange, N. J.). Pat. No. 281,687.

HYGROMETRIC APPARATUS. Atlantic Precision Co., 80 Federal Street, Boston, Mass. (Assignees of A. Allen, 16 Wildwood St., Winchester, Mass.) Pat. No. 281,693.

GYROSCOPIC APPARATUS. Gyroscector Ges., 11 Alexandrenenstrasse, Berlin, Germany. Pat. No. 281,694.

ELECTRIC METERS. S. Z. de Ferranti and and Ferranti, Ltd., Hollinwood, Lancashire, England. Pat. No. 281,743.

THERMOMETERS. C. L. Breeden, 44 Bellesley Lane, Moseley, Birmingham, England. Pat. No. 281,781.

WEIGHING APPARATUS. G. Salter & Co., Ltd., and T. W. Bache, Salter's Steam Gauge & Spring Balance Works, High Street, West Bromwich, England. Pat. No. 281,838.

ELECTRIC MEASUREMENTS, RELAYS. British Thomson-Houston Co., Ltd., Crown House, Aldwych, London, and R. D. Parry, Pen Bryn, Northway, Neasden, Middlesex, England. Pat. No. 281,943.

LIQUID METERS. Mabag Maschinenund Apparatebau Akt. Ges. and E. Neuroth, 44 Grimmell Allee, both in Nordhaussen, Harz, Germany. Pat. No. 281,952.

RANGE FINDERS. S. G. S. Dicker, 20 Holborn, London, England. Pat. No. 281,960.

LIQUID LEVEL INDICATOR. Sulzer Freres Soc. Anon., Winterthur, Switzerland. Pat. 282,013.

THERMIONIC-VALVES. Radiotechnique, 12 Rue de la Boetie, Paris, France. Pat. No. 282,028.

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The Business Manager's Page

Each month the Business Manager will have a message on this page.

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P. S. Read the Comments on Page 20.

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INSTRUMENT PIONEERS
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INSTRUMENT PIONEERS—OLIVER BLACKBURN SHALLENBERGER (1860-1898)

INSTRUMENTS, Vol. 1, No. 3, March, 1928, pp. 131-134, 1 Fig.

The life of Shallenberger is briefly given.

HUMIDITY TEST EQUIPMENT

E. B. WOOD, INSTRUMENTS, Vol. 1, No. 3, March, 1928, pp. 135-140, 3 figs.

The effects of humidity are briefly mentioned. The equipment of the Bell Telephone Laboratories for testing the action of humidity is then described. The equipment is divided into three groups: Large cork insulated rooms, air-tight stationary chambers and small portable units.

The third group is described in considerable detail. The use of sulphuric acid and saturated salt solutions for controlling humidity in the small portable units is taken up.

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INSTRUMENTS FOR THE MEASUREMENT OF ELECTRICAL INSULATION *(continued from February issue)*

A. WATSON. INSTRUMENTS, Vol. 1, No. 3, March, 1928, pp. 141-145, 1 fig.

The measurement of insulation value by three following methods is briefly mentioned.

1. Wheatstone Bridge Method.
2. High Resistance Galvanometer Method.
3. Megohmmeter, which reads directly in megohms.

The uses and limitations of these three are given.

The testing of high tension cables and live wires by means of "Kenotron" tube and transformers is taken up.

The choice of test potential and importance of inspection and testing of insulation completes the article.

DETERMINATION OF SPECIFIC GRAVITY, SURFACE MOISTURE AND VOIDS IN THE FINE AGGREGATE FOR USE IN CONCRETE MIXTURES

CLOYD M. CHAPMAN. INSTRUMENTS, Vol. 1, No. 3, March, 1928, pp. 147-150, 1 fig.

The determination of the quantities listed in the title of the article by means of a special flask is described.

ELECTRIC METER HISTORY

R. C. LANPHIER. INSTRUMENTS, Vol. 1, No. 3, March, 1928, pp. 151-162, 21 figs.

Early type of meters. Direct current meters first to be developed. Early types of alternating current meters. Types of commutator motor meters. The development of the mercury motor meter. Clock work types of meters. Oscillating type meters. Electrolytic meters. The development of the induction type meter. Induction meter art now standardized.

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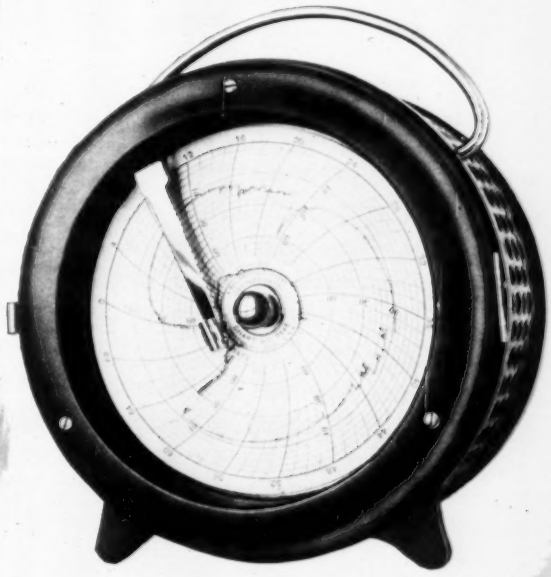

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